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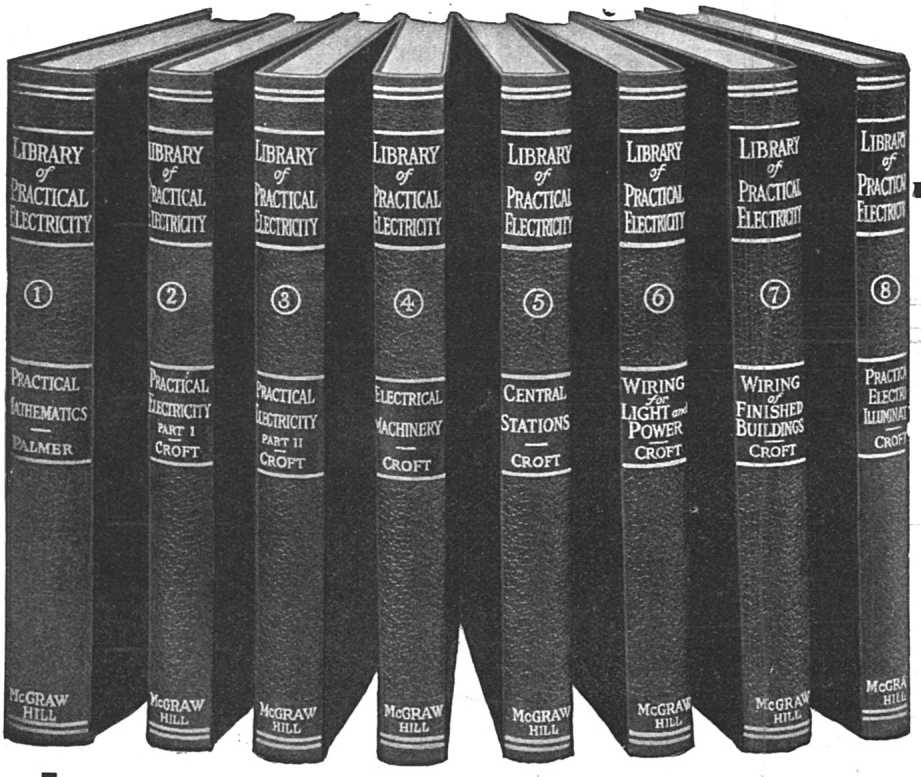

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EDITORIAL

Oil

ONE of the prime requisites of modern civilization is fuel for motive purposes. One hundred years ago, when life was less complex than it is today, commerce moved along at a slow, snail-like pace. If a merchant wished to ship his goods for only one hundred miles, the process took over a month on the average. It took the traveler three days to cover the distance from New York to Philadelphia—less than one hundred miles. It takes two hours by train today and less than one hour by airplane.

Fuel made all this possible. First it was wood that was burned as a fuel. But it was uneconomical, for its thermal output for a given weight was small. Then coal moved to the front and civilization, in less than fifty years leaped ahead farther than it had in fifty centuries. But coal, too, had its limitations. It was not the flexible, nor ideal fuel. It was satisfactory for a locomotive but not for an individual road vehicle such as the automobile, invented less than thirty years ago. The invention of the gasoline engine changed all this, and with its advent civilization and progress took another tremendous leap forward. The automobile, again depended upon a fuel—gasoline—derived from petroleum.

Now it so happens that this comparatively new fuel, petroleum, is not used solely as a fuel, but its by-products are of tremendous value to humanity as well. Of these by-products gasoline is perhaps the most important, being used chiefly in automobiles and gas engines.

Little wonder then that all the nations are drilling wells feverishly all over the world in their race for oil supremacy. For the nation which controls most of the oil may be said to lead the others today. Germany realized this too late and had she had a vast supply of oil at hand at the outbreak of the world war, the outcome might have been different. Fortunately, Germany was a negligible oil producer and could not measure up to the allies who controlled over 95% of the total supply.

Today the United States and Great Britain are the chief producers of the world's oil and both are in a frantic race to gain supremacy. Which of the two will win is problematical.

But what is petroleum? Whence does it come? Petroleum is thought by most geologists to have been derived by the destructive distillation of either animal or vegetable matter contained in the rocks. While oil is a modern fuel, as far as it is used as a prime mover, its history dates back to the Romans. Thus in Roman times petroleum was found in Sicily and it was burned in lamps. But only in comparatively modern times has it found new applications.

It is now thought that during the great upheavals in the earth's early history, when nearly every foot of land was covered with huge primeval forests, the latter were engulfed, while a new crust formed over the old land. These forests with their vast animal life then carbonized gradually, due to the earth's heat, and later by distillation were conveyed into oil and natural gas.

Large as the earth's oil deposits are, it is plain that they cannot last forever. Some day they must give out, as indeed many oil wells are becoming exhausted every year. Authorities as a matter of fact figure that our present oil supply will give out in less than fifty years.

But we need not worry. Four-fifths of the earth's surface is covered with water now, but this condition did not exist when the earth was young. We know now that vast stretches that are ocean today were once above water. By the law of averages then there must be more oil under the lands now covered with water than what is land today.

Some day we will drill oil wells far out in the ocean—that is, if we still need or want oil. This, indeed, is not a visionary scheme. There are already such ocean wells in actual use today along the coast of California as well as along the Gulf of Mexico.

H. GERNSBACK.

Vol. VIII. Whole No. 87 **Contents for July, 1920** **No. 3**

CHICAGO'S NEW MONORAIL.....Front Cover
From a Painting by Howard V. Brown

COMPREST AIR TREATMENT FOR THE SICK..... 251
By George Wall

FOILING THE DIAMOND SMUGGLER..... 252
By H. Gernsback

THE AURORA BOREALIS..... 254
By Prof. Lindley L. Pyle

SHAFTS OF LIGHT REGULATE STREET TRAFFIC..... 256
By Edwin F. Linder, M.E.

NATURE'S JEWELS..... 258
By William M. Butterfield, Illustrated by the Author

TRIPLE CAMERA PHOTOS LIGHTNING FLASHES..... 259
By Dr. Alfred Gradenwitz

NEW SUSPENDED MONORAILWAY 262

DO WE "SEE" ELECTRICALLY?..... 264
By H. Winfield Secor

ALARM NO. 18—A SCIENTIFIC STORY..... 266
By Charles S. Wolfe

MY MESSAGE TO MARS..... 267
By Clement Fezandié

THE STORY OF GLASS..... 268
By Prof. Floyd L. Darrow

OVERCOMING GRAVITATION 272
By George S. Piggott

"HOME ELECTRICS" 274
By G. L. Hoadley, M. E.

"HOME MECHANICS" DEPARTMENT..... 275
Conducted by William M. Butterfield

$50.00 AUTOMOBILE PRIZE CONTEST..... 276

TESLA GASOLINE TURBINE..... 277
By Joseph H. Kraus

IS LIFE ELECTRICAL? 278
By Rogers D. Rusk, M. A.

POPULAR ASTRONOMY—"MOTIONS OF THE HEAVENLY BODIES" 280
By Isabel M. Lewis, M. A., of the U. S. Naval Observatory

PRACTICAL CHEMICAL EXPERIMENTS—"HOMEMADE FIREWORKS" 282
By Prof. Floyd L. Darrow

CARE OF LEAD PLATE STORAGE BATTERY..... 286
By Jesse J. Hipple, Chief Machinist's Mate, U. S. N.

LISTENING FOR SIGNALS FROM MARS..... 295
By Dr. Frederick H. Millener

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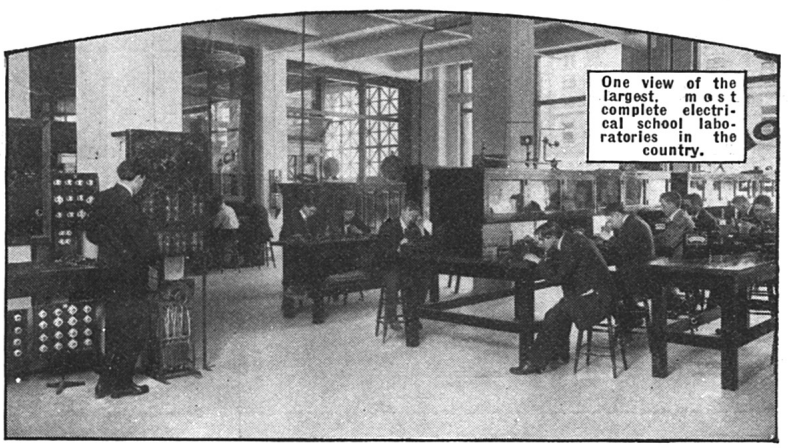

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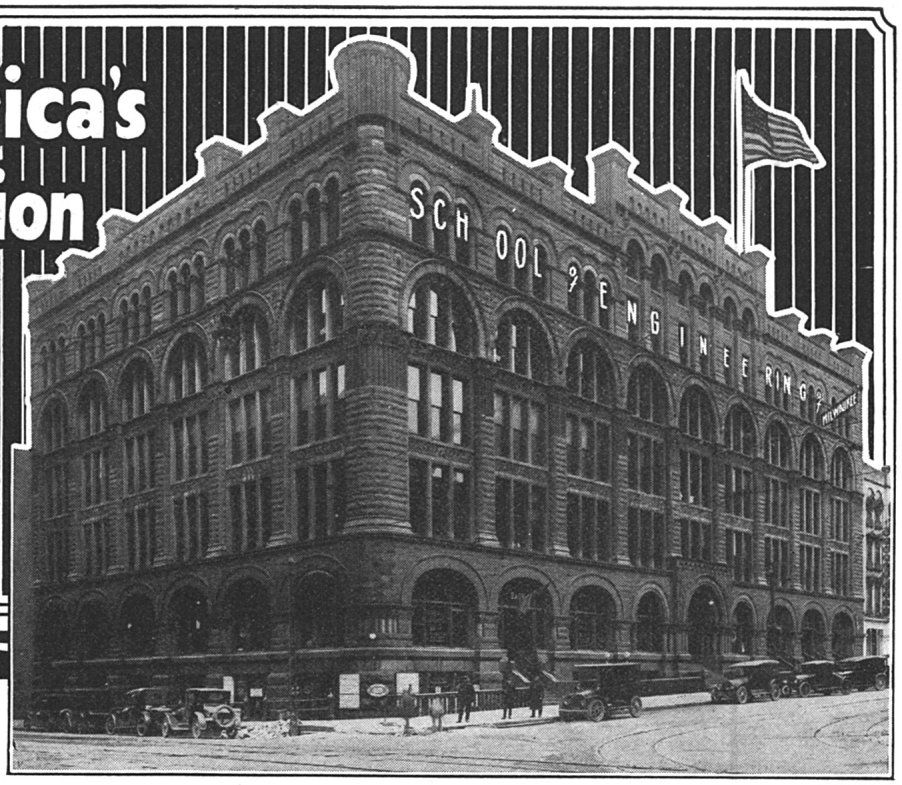

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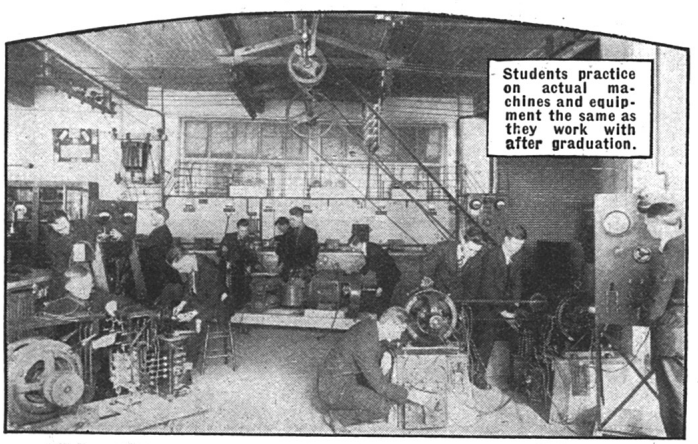

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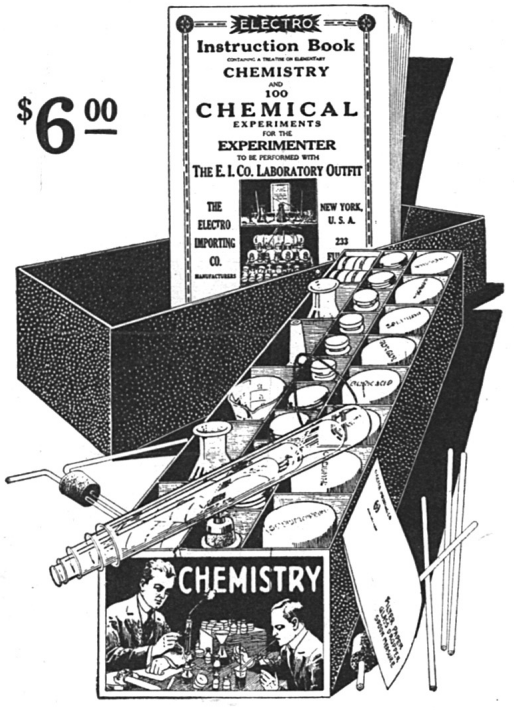

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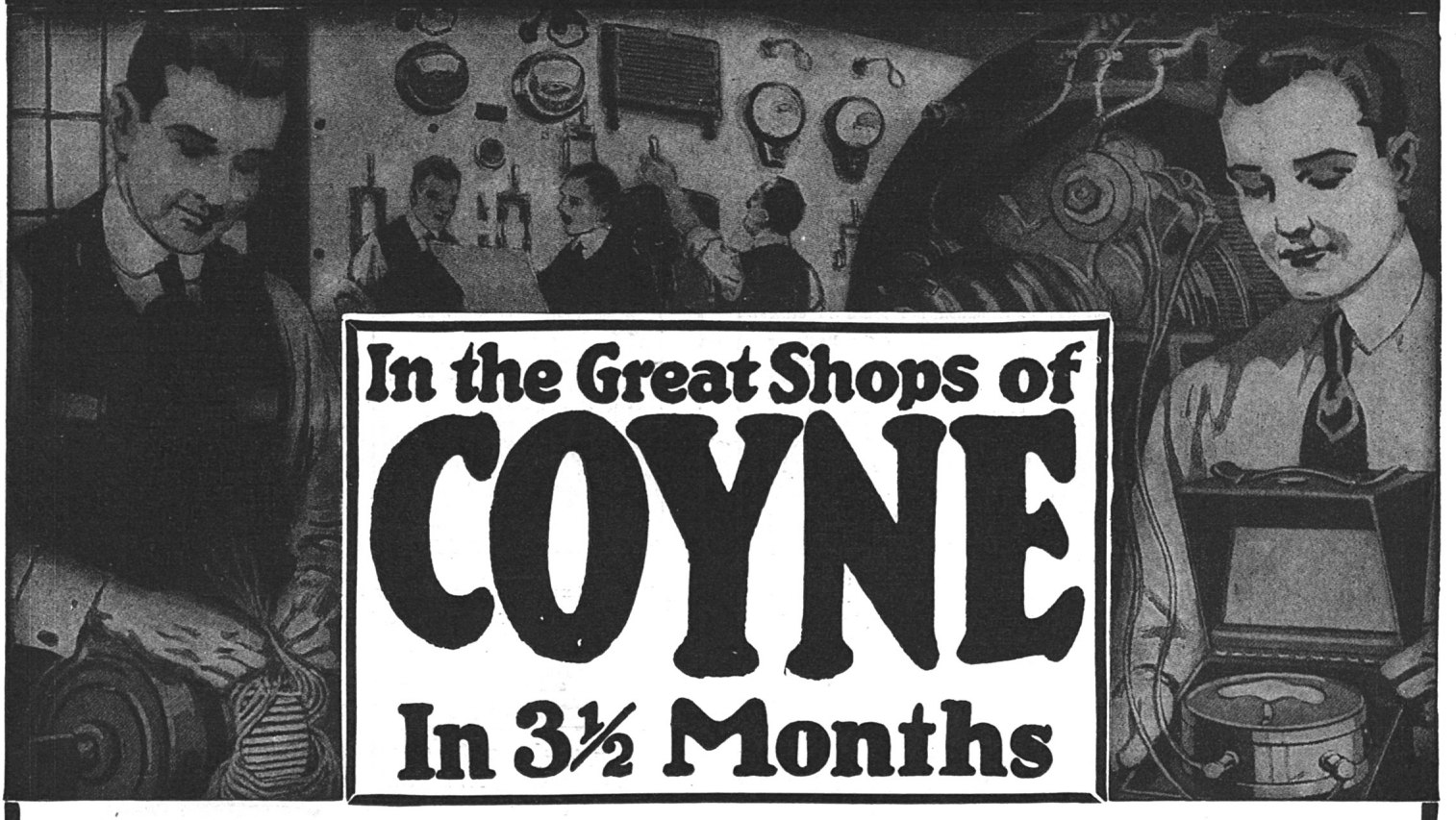

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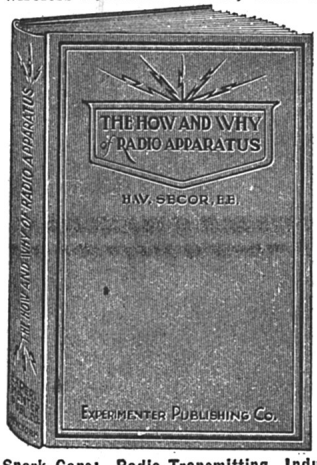

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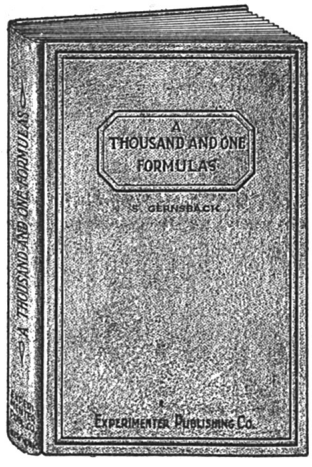

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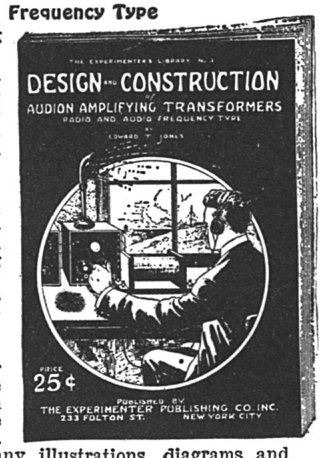

Mr. Jones, the author, is a practical man who is an experimenter himself and knows whereof he speaks. The book is printed on good paper and has an attractive cover in two colors. Paper bound. Size 5 in. x 7 in. Contains many illustrations, diagrams and working data necessary to build the transformers.

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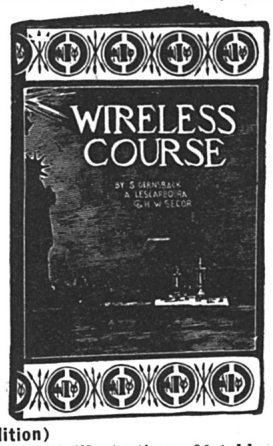

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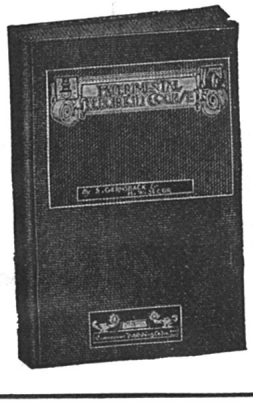

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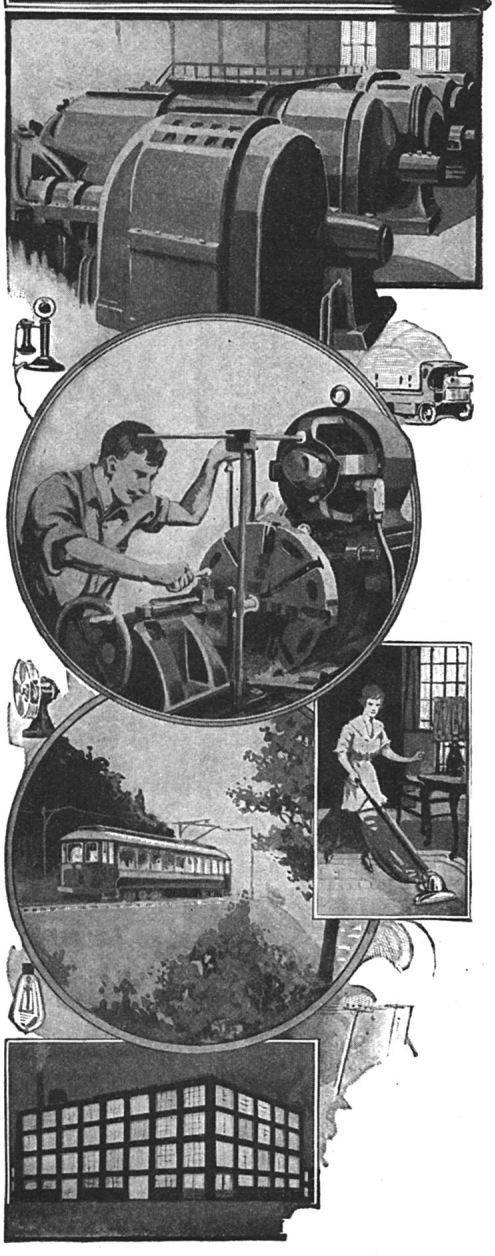

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ELECTRICAL EXPERIMENTER

H. GERNSBACK – EDITOR
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Vol. VIII. Whole No. 87 July, 1920 No. 3

Compress Air for the Sick

By GEORGE WALL

THERE are many people today who believe with the Christian Scientist, that there are at least a number of better ways for treating and curing the sick for the various ailments our human flesh is heir to than by pumping into the unfortunate victim's stomach a continual string of herbs, pills and oils.

One of the very latest scientific developments of a radical nature in medical practise is the invention here shown of Dr. O. G. Cunningham of Kansas City, Missouri. In a few words, Dr. Cunningham believes in placing the ailing patients in various compartments in this long tubular compress air steel hospital, where each patient has a different air pressure applied to their body, depending upon the particular ailment from which they are suffering.

The original steel tunnel comprising the compress air sanitarium as designed by Dr. Cunningham measured 88 feet in length by 10 feet in diameter. This steel chamber is located outdoors, and the interior of the model now in use, is fitted with sleeping compartments, after the fashion of the standard railway sleeping coach sufficient to accommodate 72 patients.

The length of the compress air treatment which is applied to the whole body varies from three to twelve hours daily and the pressure applied to the patient varies from 5 to 20 pounds per square inch above atmospheric pressure, which is approximately 15 pounds per square inch as we know.

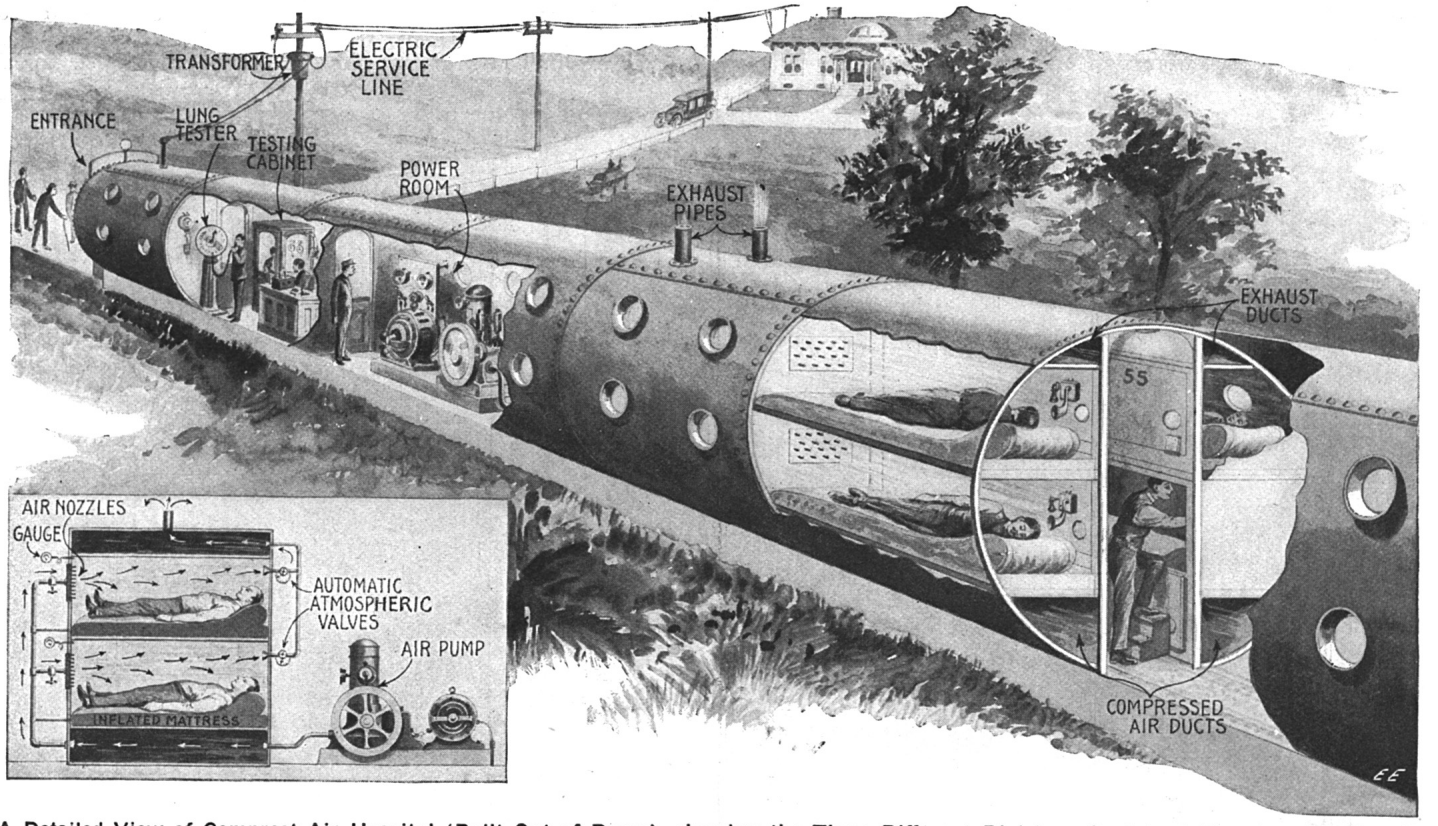
Some of the interesting effects claimed for this radical and promising treatment for human ailments are a distinct and very noticeable stimulation of bodily energy, a general quietude of the nerves, an increase of appetite, and together with this very desirable remedial feature there is obtained restful sleep for the patient.

HOW THE INTERIOR OF THE COMPRESS AIR HOSPITAL IS ARRANGED.

The accompanying illustration shows a more fully develop arrangement and layout of Dr. Cunningham's compress air sanitarium, which is somewhat larger than the 88-foot model now in use. There are many features, however small, among these being a scheme of using round glass port holes, the same as on shipboard, which provide light for the various berths or sleeping compartments, etc.

As will be seen, the length of the tubular chamber is divided off into several of these compartments, the majority of these comprising treatment chambers for the patients.

(*Continued on page* 313)



A Detailed View of Compress Air Hospital (Built Out-of-Doors), showing the Three Different Divisions Contained Therein, viz.: One for the Physician's Offices, Where Patients Are Examined; the Second for the Power Room, Where Compress Air Is Generated; and the Third Division, which Provides Separate Sleeping Compartments for Each Patient. It Is Claimed This Compress Air Treatment Is Far More Beneficial than Some of the Present-day Treatments Employing the Use of Medicines and Drugs.

Foiling the Diamond Smuggler

By H. GERNSBACK

WE were sitting in the luxuriously upholstered, oak smoking salon of the *Lusitania*. This was in the days shortly before the great war broke out. A number of diamond dealers were returning from France and Belgium, having purchased their regular supply of stones for the coming winter season. Of course, the usual smuggling stories were swapt by them and many clever accounts came to light of how a certain class of citizens, "gifted" with a perverted ingenuity, will go to extremes trying to beat Uncle Sam out of duty.

On all cut diamonds the Government collects a duty of 20 per cent. In other words, on a thousand dollars' worth of diamonds the United States collects $200. As there is keen rivalry in the precious stone business, it is of course little wonder that the attempt is frequently made to save this 20 per cent simply by smuggling in the stones.

Right here we may mention that the regular diamond merchant or dealer very seldom is willing to risk his good name and business by smuggling gems. It is usually the amateur or otherwise—altho rarely—an accomplice to a shady diamond merchant who tries to smuggle in the stones. Rich tourists are known to be the worst offenders, and women particularly take great pride in "putting one over" on Uncle Sam. These women are usually rich, and ought to know better, but they seem to look for excitement; hence the art of attempted smuggling by the rich runs into large proportions. But to come back to where we started:

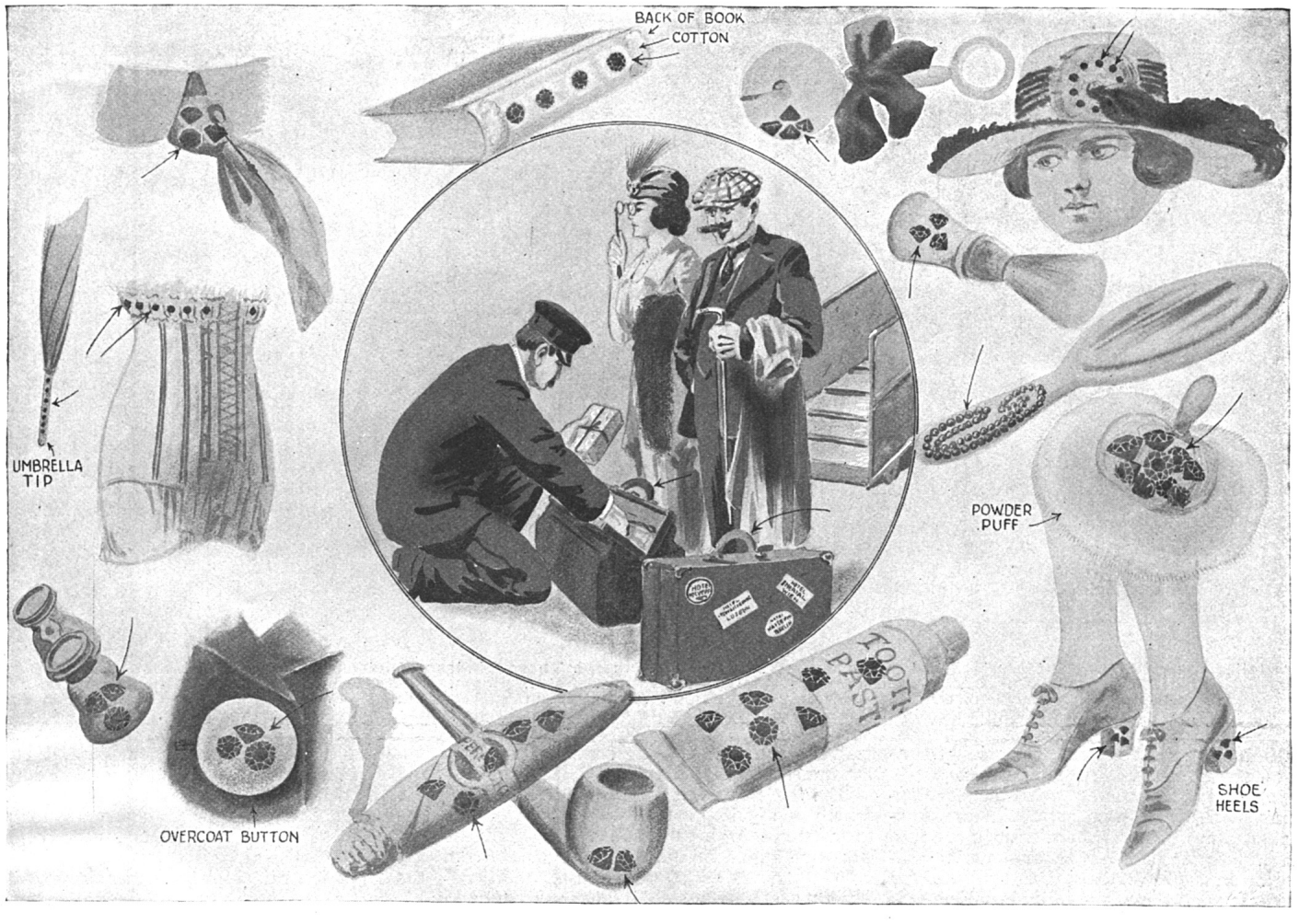
Mr. S———, a well known diamond merchant of Maiden Lane, New York, told us a vivid account of most of the usual methods of smuggling diamonds, and how they are accomplisht.

The women, he claims, go to almost any extreme, and carry the gems in the most unheard of places; thus they often baffle the cleverest custom house sleuth. Were it not that the Treasury Department maintains a foreign office that records all sales of gems made to Americans, perhaps the United States would lose a great deal more than it actually does. As the matter stands, Uncle Sam has agents in Paris or Antwerp, the centers of the great diamond activities, and as soon as a sale is recorded, the fact is immediately cabled to the United States, and nine times out of ten the person who brings the diamonds or gems into the United States is known at the time the ship docks. And in case the diamonds are not declared, the traveler is detained and a search made.

In the case of the ladies, diamonds will be found hidden in the hair, inside of powder puffs, buried in powder boxes, even hidden in lip rouge sticks. Then we have the case where a toilet mirror has its handle cunningly hollowed out, and the diamonds or pearls cleverly inserted. In this way a prominent American smuggled, not so many years ago, several dozen priceless pearls. Even the corset is used, in which the diamonds or gems are sewn in; here the top part of the bodice is usually resorted to. Then we have the ladies' millinery, which affords a convenient and safe storage for the gems. The heels of the shoes are of course old offenders, and this method of smuggling is still in use, but only by amateurs, because the seasoned smuggler would never think of such a foolish hiding place for it is here that the search usually begins.

As for the gentleman smuggler, there is hardly an object which he has not used in the past for smuggling purposes. Thus we have the inside of smoking pipes specially made for the occasion. Concealing stones in the barrels of fountain pens is an old trick. So is the tooth paste tube, backs of ebony hair brushes and clothes brushes, handles of shaving brushes, etc. Then we have the clever trick of hiding the stones or jewelry inside the knot of a four-in-hand tie, which might be overlooked by an unambitious custom house sleuth.

Some years ago one of the cleverest international smugglers frequently made trips during the winter. One day while his steamer docked in New York, one of his fur-coat buttons became entangled in a



Smuggling Diamonds Is an Art Just Like Any Other Art, so It Would Seem. Certain People With a Perverted Sense of Ingenuity Go to Almost Any Means Imaginable to Defraud Uncle Sam of Customs Duty. The Above Illustration Shows a Few Tricks Resorted To, of Which There Are Many Thousands. Tooth-Paste Tubes, Handles of Mirrors, Ladies' Powder Puffs, Baby Rattles, Cigars, Smoking Pipes, Overcoat Buttons, Backs of Books, Umbrella or Cane Tips, Opera Glasses, Tops of Corsets, Four-in-Hand Ties, All Have Been Used for Smuggling Purposes in the Past. But This No Longer Is Possible, Thanks to the Searching Eye of the X-Ray. The Accompanying Story Will Make This Quite Clear.

wire netting at the dock and one of the buttons ripped off. This man was watched by a custom house officer, as he made a much too elaborate dive for such an innocent object as an overcoat button. The Customs Inspector, however, beat him to it, and before returning the button he noticed something shiny on the inside where it was sewn to the coat. An investigation followed, and it was found that each and every one of these big buttons contained two or three fairly large cut diamonds. As there were six buttons, each containing gems, Uncle Sam was being heavily cheated of thousands of dollars duty on each trip.

Then we had the fastidious gentleman smuggler who had an elaborate toilet set containing many bottles for all sorts of medicines, ointments, etc. Of course he would not be so foolish as to place the stones inside of the ointment, because here it is where the custom house officials would search first. This particular smuggler had the corks of the bottles hollowed out and simply hid stones inside of the corks, which latter were masterpieces of deception, and served their purpose for a good many years.

I listened interestedly and attentively to these various accounts. I casually mentioned that if the custom house people were on the alert and used up-to-date scientific methods, such smuggling would be relegated to the stone age, because science has means today of combating just such smuggling. My assertion was greeted with a general ha-ha, and every one of the men present stated that if they really wanted to do smuggling, which of course they would not (Oh, no!), they certainly would find means of doing it. I thought this would be a good occasion for making good their claims, so I wagered one of the spokesmen one hundred dollars that I would be able to detect any smuggling upon his arrival in New York, no matter how cleverly he hid the diamonds. The only condition I made was that he was to bring the diamonds on shore himself hidden away somewhere either on himself or in his luggage. In other words, no trick was to be resorted to of using an accomplice to smuggle out the diamonds *afterward*. This condition was accepted and the wager placed with Mr. S———.

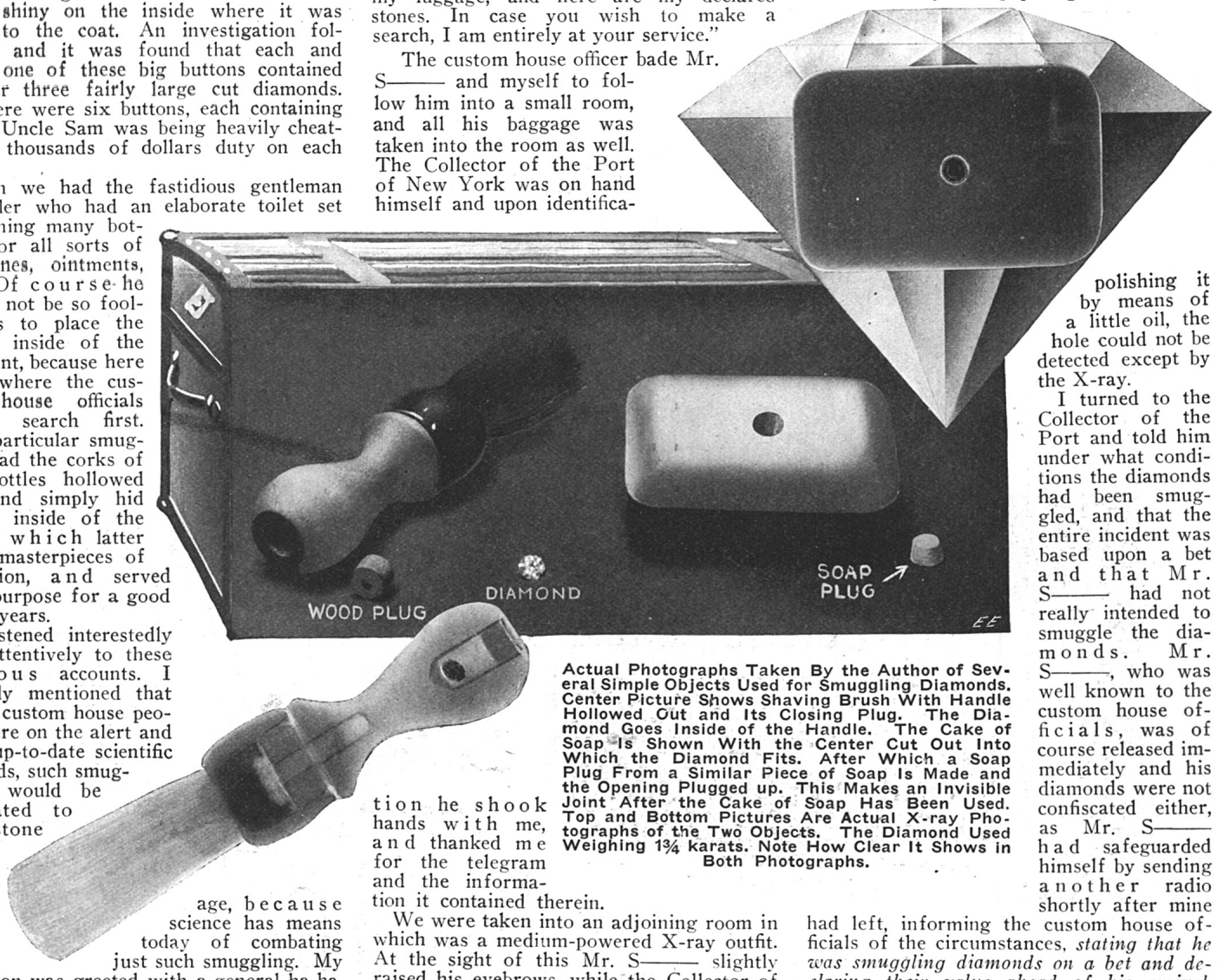
There were as yet two days left before the *Lusitania* was to dock at its Chelsea piers in New York. That evening I sent a simple telegram, not coded either, to the Collector of the Port of New York, and retired, dead sure of my hundred dollars.

The *Lusitania* duly docked in New York, and when our baggage was searched I casually strolled over to one of the Customs Inspectors and brought him over to Mr. S———. I mentioned that I had reasons for suspecting that Mr. S——— was attempting to smuggle in certain diamonds without having declared them. Mr. S——— stood by and grinned broadly and said nothing. The custom house men ran over the declaration papers of Mr. S———, on which many diamonds had been declared.

Turning to Mr. S——— he said, "I understand there is a charge against you by this gentleman that you are trying to smuggle diamonds into the United States. What have you to say?"

Mr. S——— shook his head. "Here is my luggage, and here are my declared stones. In case you wish to make a search, I am entirely at your service."

The custom house officer bade Mr. S——— and myself to follow him into a small room, and all his baggage was taken into the room as well. The Collector of the Port of New York was on hand himself and upon identification he shook hands with me, and thanked me for the telegram and the information it contained therein.



Actual Photographs Taken By the Author of Several Simple Objects Used for Smuggling Diamonds. Center Picture Shows Shaving Brush With Handle Hollowed Out and Its Closing Plug. The Diamond Goes Inside of the Handle. The Cake of Soap Is Shown With the Center Cut Out Into Which the Diamond Fits. After Which a Soap Plug From a Similar Piece of Soap Is Made and the Opening Plugged up. This Makes an Invisible Joint After the Cake of Soap Has Been Used. Top and Bottom Pictures Are Actual X-ray Photographs of the Two Objects. The Diamond Used Weighing 1¾ karats. Note How Clear It Shows in Both Photographs.

We were taken into an adjoining room in which was a medium-powered X-ray outfit. At the sight of this Mr. S——— slightly raised his eyebrows, while the Collector of the Port winkt at me knowingly. The Customs people quickly went thru Mr. S———'s baggage, and selected such objects as they thought were of particular interest to them. They probed and shook his shoes to see if there were any concealed stones in the heels, and set them carefully aside along with all the other objects. One of the men then started the X-ray apparatus and inspected each and every suspected object thru the fluoroscope. Shoes, hair-brushes, pipes, etc., were soon eliminated, but when the operator came to a cake of toilet soap, he smiled broadly and laid it aside. Several more objects gave negative results until he came to the shaving brush. One look and more broad smiles. Finally Mr. S——— was asked to stand in front of the bulb and he was carefully X-rayed, not a part of his body escaping the merciless rays that search out everything. But there was nothing hidden on Mr. S——— as far as could be learned.

The operator then shut off the current and turning on the light again, which had been turned off while the search was going on, he took the cake of soap and broke it in two. Sure enough, inside of it there was a 1¾-karat diamond hidden in a hole neatly cut out by means of a penknife. From another piece of soap a plug had been fashioned, the hole closed up, and after Mr. S——— had washt his hands a number of times no one could have told that the cake of soap contained almost a thousand dollar diamond.

The case of the shaving brush was almost identical. Mr. S——— had whittled a hole into the handle of the brush and had hidden therein one big diamond. The hole had then been closed by a wooden plug from a similar piece of wood, and after carefully sandpapering the end and polishing it by means of a little oil, the hole could not be detected except by the X-ray.

I turned to the Collector of the Port and told him under what conditions the diamonds had been smuggled, and that the entire incident was based upon a bet and that Mr. S——— had not really intended to smuggle the diamonds. Mr. S———, who was well known to the custom house officials, was of course released immediately and his diamonds were not confiscated either, as Mr. S——— had safeguarded himself by sending another radio shortly after mine had left, informing the custom house officials of the circumstances, *stating that he was smuggling diamonds on a bet and declaring their value ahead of his arrival.* For that reason, of course, there was no legality for confiscating the diamonds, altho technically there had been an attempt at smuggling.

My bet having been paid, we shook hands all around and departed.

The moral of the story is that today diamonds cannot be smuggled successfully, no matter how cunning the plan. The X-ray will show up a concealed diamond, pearl or other precious stone, as clearly demonstrated by the accompanying photographs, which are those taken of a genuine 1¾-karat blue-white diamond hidden in various ways.

A peculiar thing in connection with such X-ray pictures is the fact that it is not necessary that the diamond shows up very strongly. As a matter of fact, a perfect diamond without any flaws at all does not show very well in an X-ray photo. Nevertheless a smuggler would be convicted by the fact that even if the stone does not show, the cavity in which it is hidden does. No matter how carefully the plug is made, it is never possible to make it so that it will exactly follow the original grain of the substance. This is clearly shown in the above photographs.

Pearls, rubies, emeralds, etc., show up somewhat clearer under the X-Ray than diamonds.

Well meaning but misguided smugglers will take heed and divert their ingenuity to more fruitful channels.

The Aurora Borealis

By LINDLEY PYLE

Professor of Physics, Washington University, St. Louis, Mo.

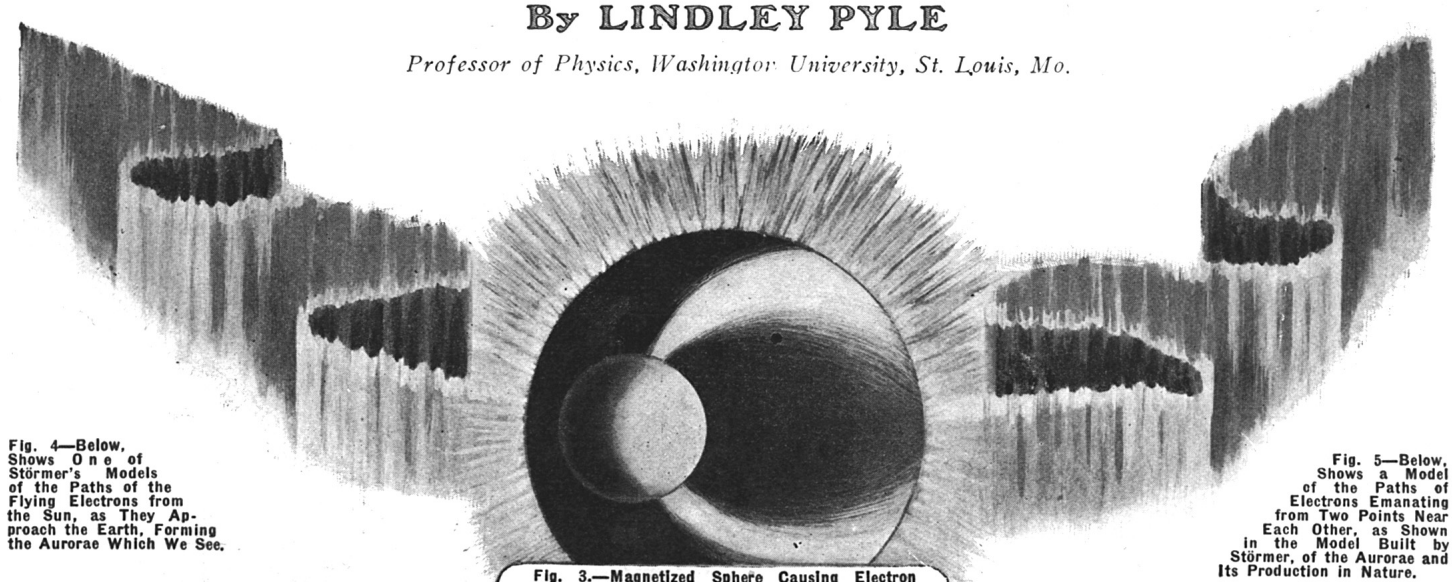
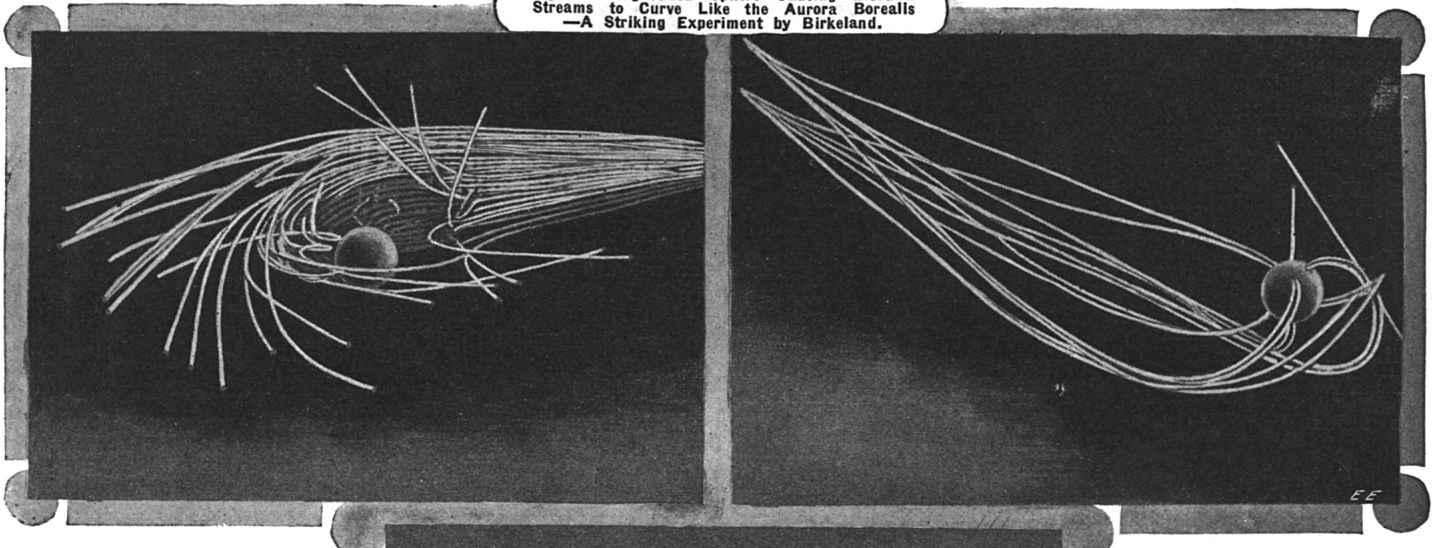


Fig. 4—Below, Shows One of Störmer's Models of the Paths of the Flying Electrons from the Sun, as They Approach the Earth, Forming the Aurorae Which We See.

Fig. 5—Below, Shows a Model of the Paths of Electrons Emanating from Two Points Near Each Other, as Shown in the Model Built by Störmer, of the Aurorae and Its Production in Nature.

Fig. 3.—Magnetized Sphere Causing Electron Streams to Curve Like the Aurora Borealis —A Striking Experiment by Birkeland.



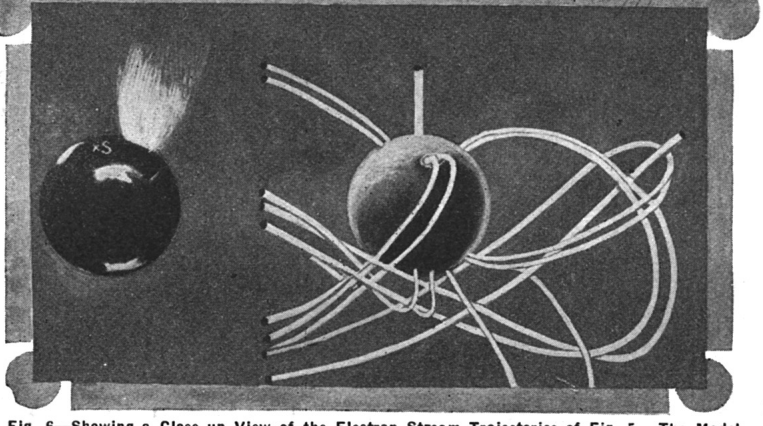


Fig. 6—Showing a Close-up View of the Electron Stream Trajectories of Fig. 5. The Model Shows How the Paths Penetrate Into the Earth's Atmosphere Near the North and South Magnetic Poles. The Illustration at Left Shows the Luminous Patches Obtained by Birkeland on the Magnetized Globe, When Exposed to a Stream of Electrons Artificially Produced, by a Cathode Ray Discharge.

AURORAL displays constitute one of the most beautiful and awe-inspiring of natural phenomena. Tho representing a type of electrical discharge, they lack the deadliness of the terrifying lightning bolt, and one may enjoy their loveliness without fear of bodily harm. Only in recent years has a theory been developt that seems adequate to explain the observed facts.

A study of the spectrum obtained by passing the auroral light thru a prism identifies the phenomenon as the luminescence of low-pressure gases emitting light under the impact of high-speed electric-charges. The most plausible theory of auroral formation is largely the result of the joint contributions of two Norwegian scientists, Kristian Birkeland and Carl Störmer. Birkeland assumes that electrons (the ultimate and indivisible negative charges of electricity) are shot off from the heated surface of the sun. Entering the earth's magnetic field with a speed of possibly 50,000 miles per second, or more, the electrons are deviated thereby into certain paths or trajectories. At an enormous expense of labor Störmer has calculated the forms of the possible paths of the flying electrons and has fitted theory to fact to a most astounding degree. Variations in solar activity, sun-spots, etc., would necessarily vary the intensity of emission of the electrons and, according to the Birkeland-Störmer theory, one readily links up with variable solar activity a corresponding variation in auroral display, as well as terrestrial magnetic storms which usually accompany the aurora.

Figures 1 and 2 are reproduced from Jean Becquerel's article in the February, 1920, issue of the ELECTRICAL EXPERIMENTER. These photographs have a direct bearing upon the Birkeland-Störmer auroral theory in that they show the path followed by cathode rays (high-speed electrons) when projected into a *uniform* magnetic field where the lines of magnetic force are respectively perpendicular (Fig. 1) and oblique (Fig. 2) to the line of projection of the electrons. Now, the lines of force of the earth's magnetic field converge as they enter the polar regions, hence electrons entering the magnetic field obliquely will, under proper initial conditions, follow a conical, spiral trajectory toward one or the other of the earth's magnetic poles.

Fig. 3 is a photograph of a remarkable experiment performed by Birkeland. Suspended in a highly exhausted vessel is a magnetized sphere. To the right and beyond the limits of the photograph is a negatively charged disc, highly electrified. Under the intense electric forces near the disc the electrons associated with the molecules of the residual gas in the evacuated space are hurled away from the vicinity of the disc at tremendous speeds, constituting a so-called cathode ray discharge toward the magnetized sphere. Now the sphere is surrounded by a magnetic field similar to the field of the earth and the photograph presents beautiful evidence of the action of the field in concentrating the cathode stream into the regions near the magnetic poles.

Figure 4 is one of Störmer's models of the paths of the flying electrons from the sun as they approach the earth (dark sphere in the model). Figure 5 is a model of the paths of electrons emanating from two

points near each other and Figure 6 is a nearer view of the same trajectories, the model showing how the paths penetrate into the earth's atmosphere near the north and south magnetic poles. The *right* side of Fig. 6 shows Störmer's *calculated* paths of the luminescence-producing electrons; the *left* side of Fig. 6 shows the luminous patches obtained on the Birkeland magnetized globe when exposed to a stream of electrons artificially produced by a cathode ray discharge. The agreement of experiment with theory as to the locations on the globe of the artificial auroral displays is most remarkable indeed.

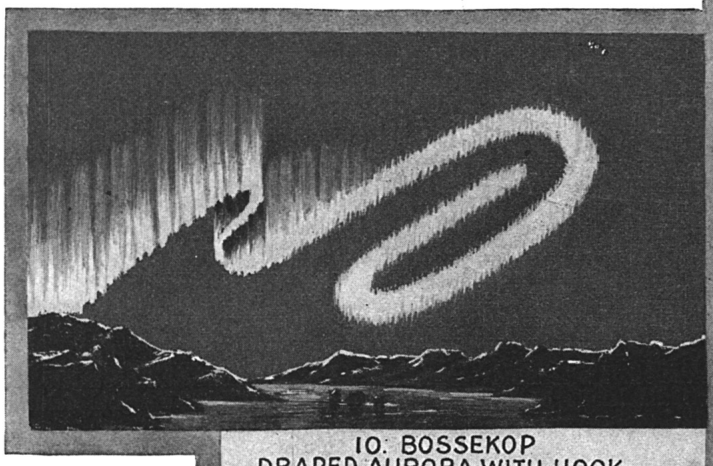
Figures 7 to 10 inclusive give one an excellent idea of the appearance of certain characteristic types of auroras. These are photographs of the actual auroral and they embrace the entire sky from horizon to zenith. The auroral colors, which do not reproduce in these photographs, are silvery-white, yellow, green, and red. It is stated on good authority that an imaginary line connecting the center of the corona and the observer's eye is quite closely in line with the dip-needle,—that is, in line with the magnetic lines of force of the earth's field. Figure 9 is an excellent example of auroral *curtains* or *draperies.*

In 1913 at Bossekop, Norway, Störmer obtained some remarkably fine auroral photographs. His purpose was to determine the height and position of the aurora in space. One camera was located at Bossekop and another camera at Store Korsnes, about fifteen miles distant. By aid of telephonic communication the same auroral feature was photographed simultaneously from the two stations. Knowing the distance between the two stations, as well as the angles, the distance of the auroral point from Bossekop could be computed by a simple trigonometrical formula. The altitude above the earth could then be readily calculated. In one month 447 successful pairs of simultaneous photographs were thus taken. Störmer states that the year 1913 was a very marked minimum year for the frequency of solar activity, auroras, and magnetic storms; hence that it is probable that the very high lower limit of 87 kilometers was due to the small penetrating power of the electric corpuscles emanating from the sun,—the corpuscles being stopped in the outer parts of the atmosphere. From previous altitude measurements it seems that the lower limit of the auroral displays is much lower during years of maximum frequency.

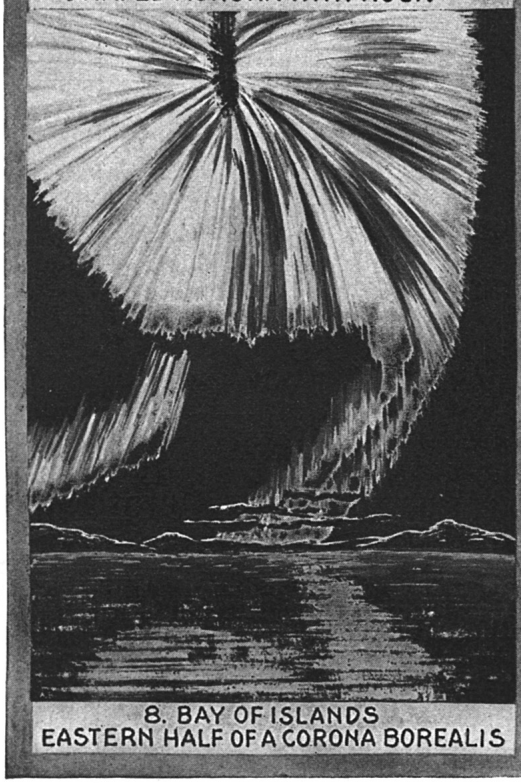
It is well known that magnetic disturbances accompany auroral displays, especially when the aurora appears well down in the temperate zones. Telegraph companies report "earth currents" involving hundreds of volts. In one case Störmer was able to examine in detail the magnetic disturbance accompanying an auroral display of great brilliancy in which an auroral curtain, or drapery, appeared in the west and moved overhead and into the northeast at a mean height of 60 miles. The data recorded shows that *in four minutes the drapery moved across the sky approximately* 280 *miles,* which is an average speed of over a mile a second—twice the speed of a rifle bullet. Fortunately a magnetic observatory at Haldde, seven miles west of Bossekop (Norway), was able to furnish automatic records of the accompanying local magnetic storm, as explained by the writer in the January issue of the ELECTRICAL EXPERIMENTER. It should be understood that the magnetic disturbance did not arise primarily from the motion of the auroral drapery across the sky but *took its origin in the descent into the earth's atmosphere of electrified particles emanating from the sun and deviated from their original course by the magnetic field of the earth.* Now a moving electrical charge is equivalent to an electric current and is accompanied by magnetic lines of force whose direction are dependent upon the direction of motion of the charge and the sign of the electrification—positive or negative. It was found that the magnetic disturbance accompanying this particular auroral display was such as would be produced by *positively* charged particles penetrating downward into the atmosphere of the earth. Yet in the case of the Ryder Polar Expedition (1891-92) it was noted many times that an auroral curtain passing rapidly overhead from south to north deviated a compass needle in such a way as to correspond to the penetration into the atmosphere of *negatively* charged particles.

It seems not unreasonable that both of these phenomena may be accurately reported in that both positively and negatively charged particles may play rôles in auroral phenomena. Professor Vegard of the University of Christiania has publisht data in favor of the positively charged particle theory, whereas Birkeland has supported the negative charge theory. Vegard states that it is hardly possible to doubt that electrical radiation from the sun is the main cause of the aurora, and he offers rather convincing reasons that the particles emanating from the sun are the same as the so-called alpha-particles discharged from radioactive substances—in other words, simply positively charged helium atoms. Vegard uses Störmer's calculations

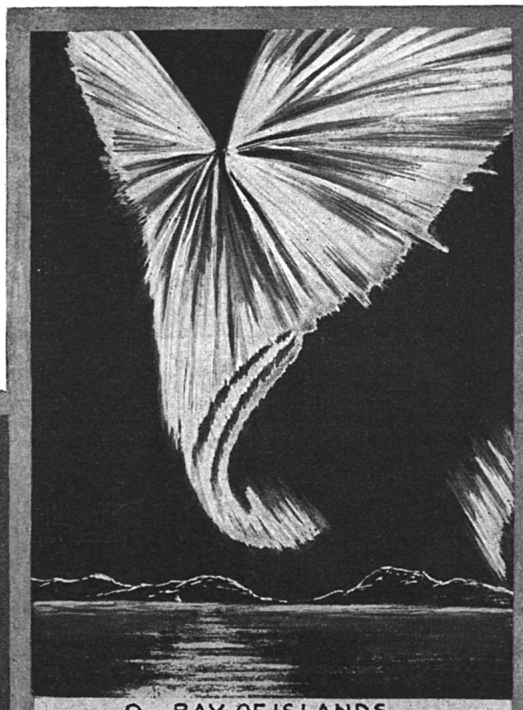
(*Continued on page* 345)



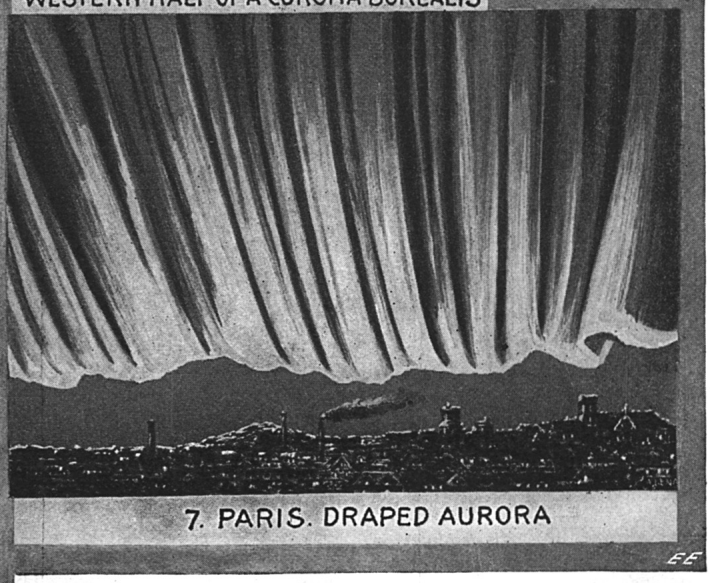
10. BOSSEKOP
DRAPED AURORA WITH HOOK



8. BAY OF ISLANDS
EASTERN HALF OF A CORONA BOREALIS

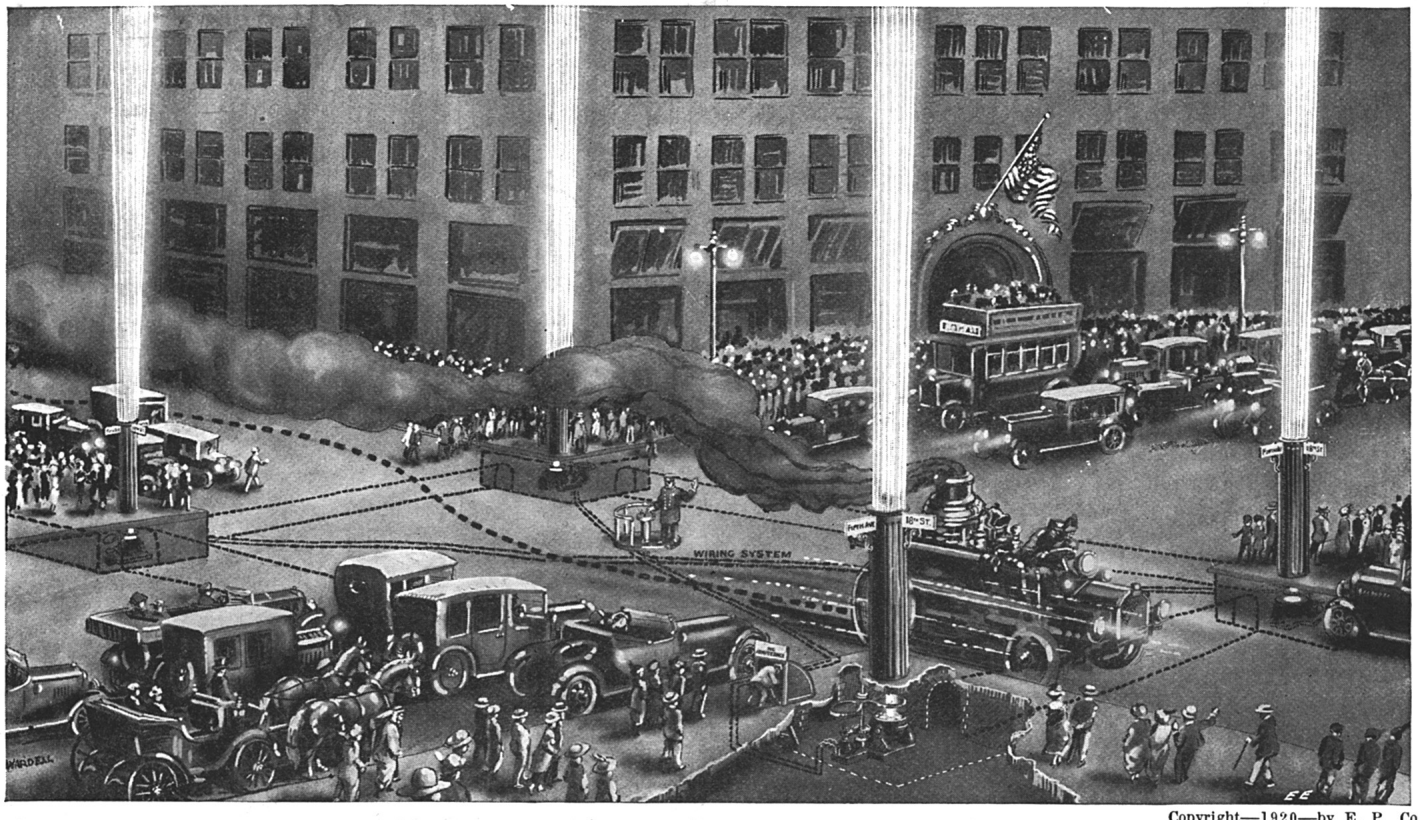


9. BAY OF ISLANDS
WESTERN HALF OF A CORONA BOREALIS



7. PARIS. DRAPED AURORA

EF



Copyright—1920—by E. P. Co.

An American Inventor Here Proposes a Clever Idea for a Traffic Signal On a Street Crossing in Large Cities, Which Instead of a Large Tower Erected in the Center of the Street, As Now Used On Fifth Avenue in New York City, Involves the Use of Four Vertical Searchlight Beams Placed On Four Corners in the Manner Illustrated. Different Colored Beams Could Be Thrown Upward, Or White—To Go Ahead; Red—To Stop; and Possibly a Third Color, Indicating the Signal to Clear the Street Or Leave a Channel for the Purpose of Fire Or Ambulance Apparatus.

Shafts of Light Regulate Street Traffic

By EDWIN F. LINDER, M. E.

THE problem of regulating the traffic of the fast motor-driven vehicles in the congested districts of large cities is becoming more difficult with the rapid increase in the number of automobiles, motor-cycles and buses being substituted for other less efficient transit appliances. The change of conditions brought about by the introduction of modern methods of travel has recently made it necessary in 5th Ave,, New York to install mechanical devices to assist the traffic officers in controlling systematically this endless chain of vehicles and the many thousands of pedestrians for whom the crossings at times must be kept free, to prevent accidents and possible loss of life. At night it is extremely difficult to co-operate satisfactorily with the officials, as the apparatus now in use for the purpose of signaling is not conspicuous enough, and does not give warning to such as may be at a considerable distance from the traffic station.

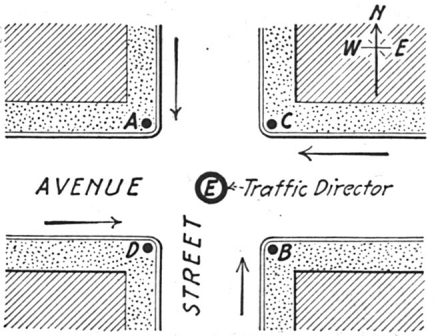
VERTICAL LIGHT SHAFTS TO REGULATE STREET TRAFFIC.

To improve the present methods it is proposed to send up vertical shafts of *white* and *red* searchlight beams, which would stand out in sharp contrast to the glitter of myriads of electric lights of many colors and the usual street lights along the sidewalks.

At the crossings where this type of installation is to be made an under ground chamber is constructed at each of the four street corners; they are connected with passages to enable a man to pass from one to the other and to gain access to the system one manhole is placed conveniently above one of the chambers. On the surface, close to the curb a hollow column is mounted thru which the beam of the search light is directed. The height of this column is twelve feet from the street level. This arrangement keeps the other wise blinding rays of light above the heads of the people. Glass covers the top of the columns.

SIZE OF SEARCHLIGHT PROPOSED.

In each chamber, directly underneath the



This Diagram Shows How the Searchlight Traffic Regulating Scheme Proposed By the Author, Works Out. The Method of Applying It, is Simple Indeed. The Traffic Policeman, Stationed in the Center of the Street Cross-over, Has a Push-button Switch Control mounted On a Pedestal Beside Him, By Means of Which He Can Regulate the Colors Flashed from the Searchlights.

columns is mounted a searchlight capable of projecting a beam of approximately eighteen inches in diameter. As the beam is always directed vertically, this apparatus can be of simple construction and is rigidly mounted on a suitable platform along with the other necessary mechanisms. An electric motor operates a duplex frame; one wing of which contains ruby glass for producing the red shaft of light, when placed over the top of the search-light, and the second wing is covered with sheet metal which serves as a shutter and obstructs the light from passing thru the signal column overhead. The searchlight is equipt with the usual auxiliary devices necessary for its operation as a unit from a central controlling station, preferably a pedestal mounted upon a small circular platform, located in the middle of the intersecting streets. It is on this platform that the "traffic officer" stands to direct the movements of the vehicular and pedestrian traffic. On the top of the pedestal are attached push-buttons operating the various switches to set in motion the mechanisms in each of the four signal chambers. By the means of these pushes it is possible for the officer to quickly send forth any signal or combination he finds necessary during the performance of his duties.

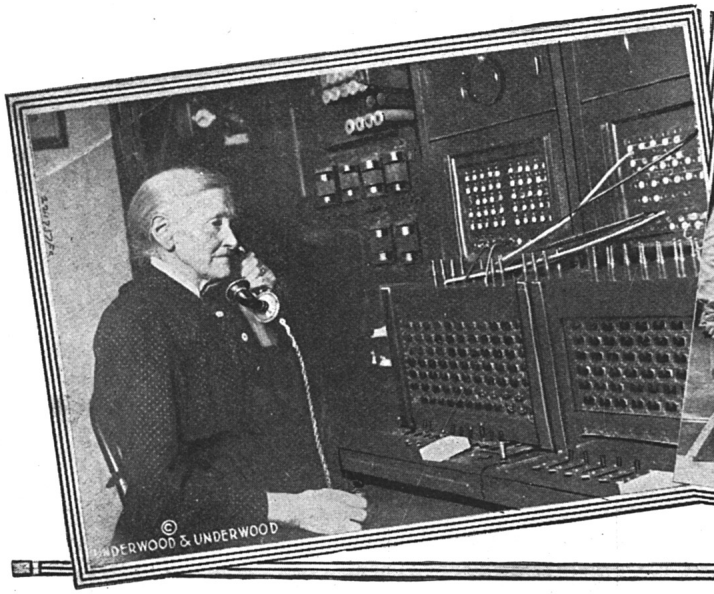
HOW THE LIGHT SIGNALS WORK.

To get a clear idea of the working of this system a practical example with the accompanying diagram is given. The signal columns are marked respectively A, B, C and D. The officer is located on the raised platform E. Arrows show the customary direction in which traffic takes place.

Assume that the officer in charge takes his station to commence directing the night traffic. He pushes down a switch in the pedestal lighting up all four searchlights, at the same time pressing the button which operates the motors of all four duplex frames, simultaneously flashing forth out of the four columns the "all stop" signal; then at A-B-C- and D, four red shafts of light will be seen extending upward and which can be noted at a great distance.

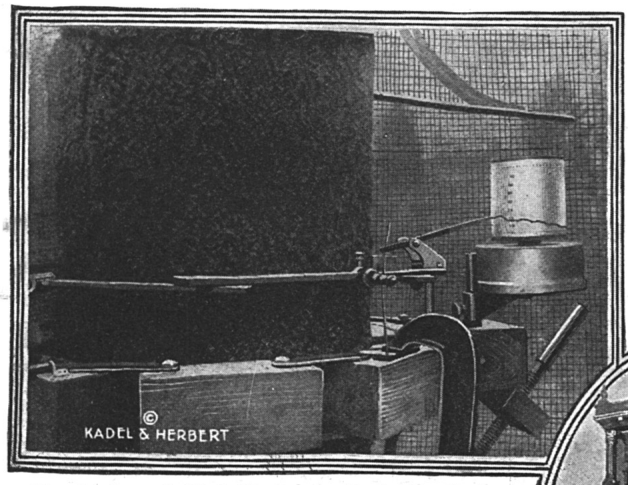
(*Continued on page* 345)

Science In Latest Pictures



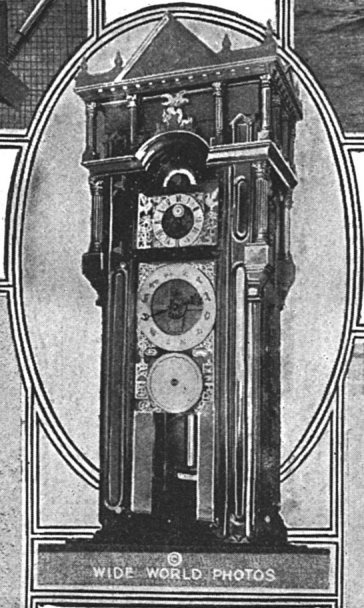
At the Age of 80, After 21 Years of Service, Mrs. Elizabeth Andrews, England's Oldest Telephone "Girl," Has Just Retired. She Has Served at an Exchange at Ferriby, About 10 Miles from Hull, and Celebrated Her 80th Birthday a Month Ago. Her Hearing Is Still Fairly Good But Her Sight Causes Her Increasing Trouble So She Has Sent in Her Resignation.

Complete Radio Telephone Set at the Washington Exhibit. The Complete Radio Telephone Set Used at the Annual Army Air Tournaments at Bolling Field, Washington, D. C. For Handling All the Events, Including Plane Races, Stunts, Combats, Etc. The Apparatus Was Demonstrated by Experts in the Aerial Service of the Army.

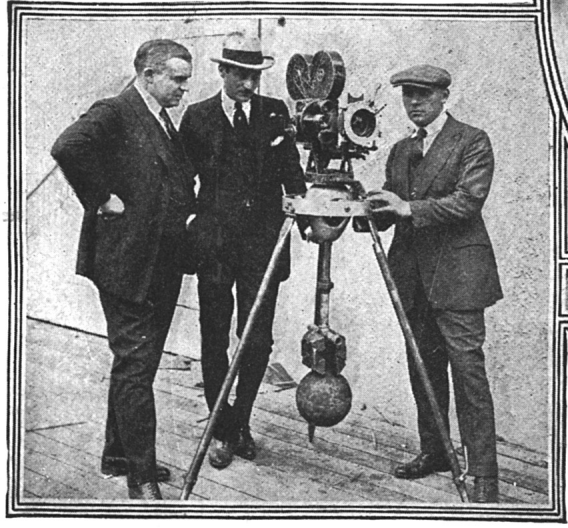


The Dendrograph That Measures a Tree's Growth by Recording on a Drum Showing from Week to Week the Actual Growth of the Tree. The Other Parts of the Apparatus Are the Collar and Belt of the Block Which Encircles the Tree and the Recording Rod Which Marks the Tree's Growth on the Cylinder. The Photo Shows the Dendrograph Installed to Measure the Growth of a Tree.

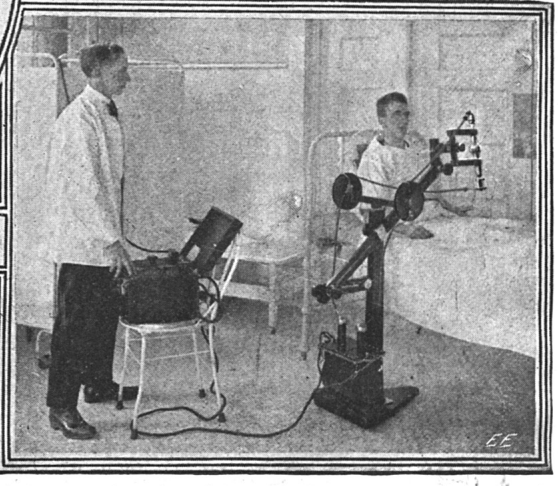
A New Type of Air-Propelled Boat Built by the French Which Makes a Speed of 74½ M.P.H. on a Half Mile Basis. This Speed Performance Probably Constitutes a World Record. Various Types of Gliders Are Now Practicing on the Seine for the Coming Monaco Races. The Photo Shows the De Lambert Glider, Which Has Been Designed for Passenger Service on Shallow Waters, Driven by an Aviation Engine.



The Calendar of This Clock Is Arranged for 10,000 Years, Even the Double Leap Years Being Provided For. The Upper Dial, Two Feet In Diameter Marks the Time with Absolute Accuracy and Is Governed by an Eight Day Movement. There Are Twenty-four Other Dials Showing the Hours Variation In Time at 127 Principal Cities of the World. Above the Time Dials Are the Moon Frame Giving the Phases of the Moon and the Earth and Its Revolutions About the Sun, Variations of the Seasons, the Months, and Days In the Month. Another Dial Gives the Longitude East and West of 127 Degrees of Principal Cities of the World.



Motion Picture Camera Mounted on Gimbals Devised by C. E. Shurtleff, for Purposes of Taking Motion Pictures on Shipboard. The Contrivance Was First Tried Out In the Filming of the All-Star Production of "The Mutiny," from Jack London's Novel, "The Mutiny of the Elsinore." It Keeps the Camera Level, No Matter How Rough the Sea. C. E. Shurtleff, the Inventor, Appears at Left.



Dr. W. D. Coolidge and His Associates In the Research Laboratory of the General Electric Company Have Recently Perfected a Remarkable Portable X-Ray Outfit. The U. S. Army Portable Outfit Which They Devised Rendered Service of a High Order In the European War. It Is Now Possible For Any Doctor to Transport the Entire New Outfit, Packed In Four Hand-borne Units, to Any Home Wired for Electricity and Produce Radiographic Results as Good as Those Secured In a Completely Equipt X-Ray Laboratory.

Nature's Jewels

By WILLIAM M. BUTTERFIELD

The Wonderland of Crystals

EVERY jewel, even MAN—the jewel without a price—is a nature jewel; therefore our title, "Nature's Jewels" is a breach of tautology which should be explained to the indulgent reader at the outset of this investigation. In defence of this intentional *ology* we hasten to say that our contribution must, at the beginning at least, be presented to the usual critical audience with the common assumption that there are jewels and jewels.

Some for instance, that man calls precious stones, those which lapidaries chip and polish to suit his peculiar tastes. Then there are some which we will describe that are manufactured by Nature—unassisted by man—which he, we are forced to say, has never considered particularly pleasing in their undecorated state. For certain obvious reasons our reasonable reader must willing admit that in these enlightened days one must not trespass too freely upon the field of popular understanding.

Jewel is derived from the Italian "gioja" meaning joy. But it will require an extreme optimist to find anything approaching that hilarious sentiment attached to the pebbles men call diamonds, rubies, emeralds or the like. Man has always resented the encroachment of nature upon what he is pleased to consider, his superior domains. As a jewel maker or as a jewel namer he claims to stand in a class by himself. In the naming we are willing to award him the palm for exceptional ability, but as a regular maker of jewels we are afraid it is necessary to deny his claims in taste. The best he has ever been able to do is to hack off the corners or otherwise manhandle the products of nature. At the cost of much treasure; at times after rivers of human blood have been made to flow, he (as with the Kohinoor diamond) obtains one of nature's rare products. This he cuts, forming numerous faces, fashioned in the highest possible state of his skill, but his exceptionally delicate ornamentation of the stone, fine as it really is, does not equal in finish or line the common forms of nature's own jewels, strange as it seems.

Even in manufacturing imitation jewels, such as the glass or paste kind, he is compelled to seek nature's help to provide him with the materials from which these commonly supposed artificial products are formed. And She practises jewel making right before his eyes, usually without his being aware of the fact. No rigid substance, not even the bone or other hard parts of the human body, is formed without Her singular aid.

Jewel-making on a scale sufficiently large to include the original of every solid substance in the universe is surely considerable of a task. Yet this is only a part of Nature's work in their construction. We shall find that solids are first formed from liquids, and it is just at the time when the liquid is turning into a rigid form that Her jewels are made—a process sometimes called the "crystallizing of solids" or "crystallization." These creations, which by their countless numbers and growth form a solid are what we call "Nature's jewels."

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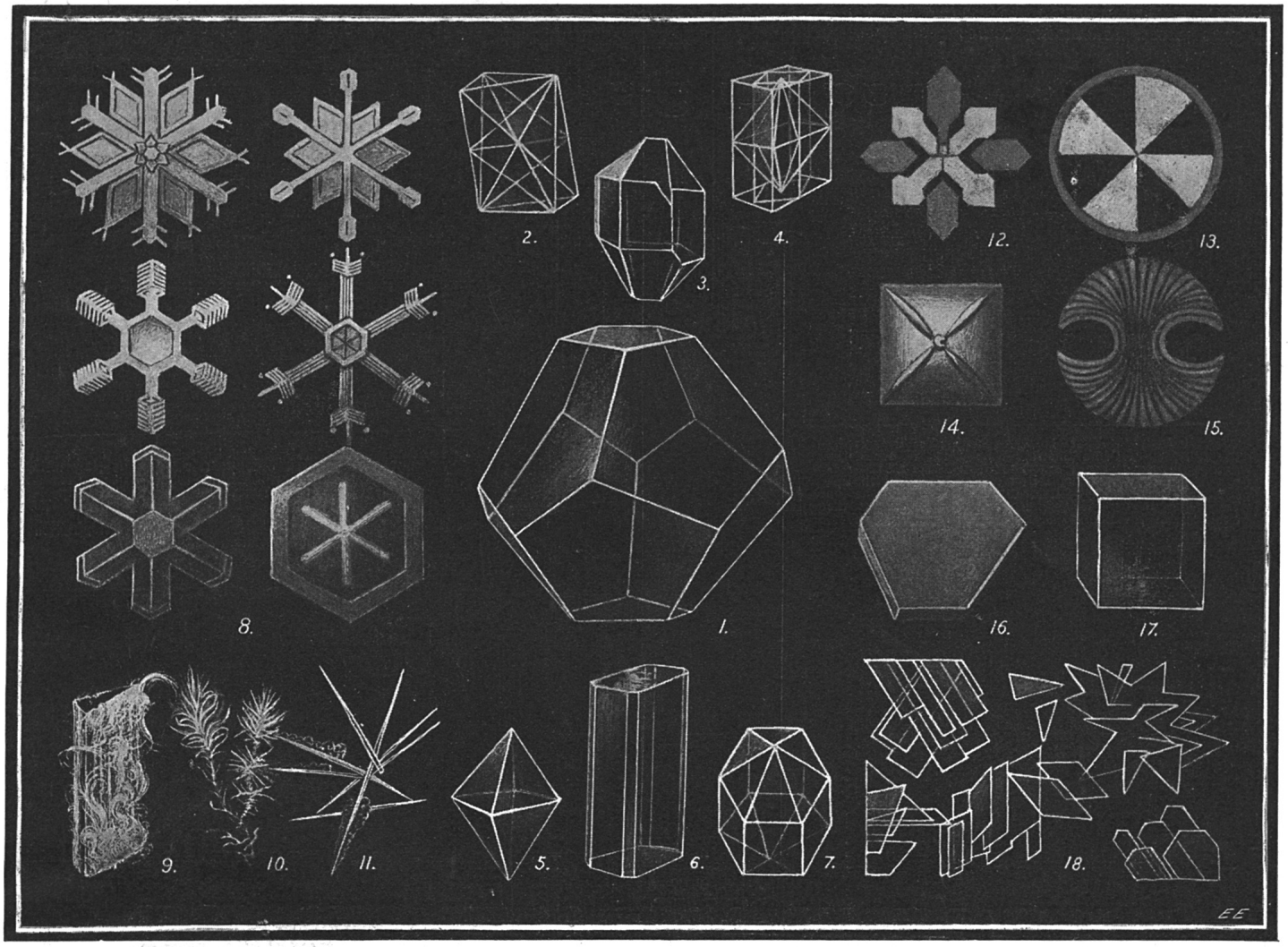


LEAF-LIKE OR FOLIATE CRYSTALS.

Fig. 8. Six Compound Snow Crystals.
Fig. 12. Compound Crystal Sulfate of Iodo-quinine.
Fig. 13. Crystal of Quinidine (Under Polarized light).
Fig. 18. Varieties of Cholesterine Thin Crystals.

THREAD-LIKE, FIBER OR NEEDLE CRYSTALS.

Fig. 9. Soft, Wool-like Crystals of Asbestos (Amianthus) Hornblend.
Fig. 10. Tufted Foliage Crystals of Flowers of Benzoin (Benzoic Acid) from Gum.
Fig. 11. Microlithes (Belonites) from Pitchstone.

Fig. 15. Common Dumb-bell Crystal from Oxalate of Lime.

KNOTTED OR GRANULAR FORMS OF CRYSTALS.

Fig. 1. Garnet Crystal (Perfect Dodecahedron).
Fig. 2. Amethyst crystal.
Fig. 3. Quartz crystal.
Fig. 4. Crystal of Potassium.
Fig. 5. Diamond Crystal (Perfect Octahedron).
Fig. 6. Sanidine Crystal (Tabular Form).
Fig. 7. Quartz Crystal.
Fig. 14. Oxalate of Lime Crystal (Octahedral form).
Fig. 16. Titaniferous Iron Crystal.
Fig. 17. Cube Crystal of Sodium Chlorid (Salt).

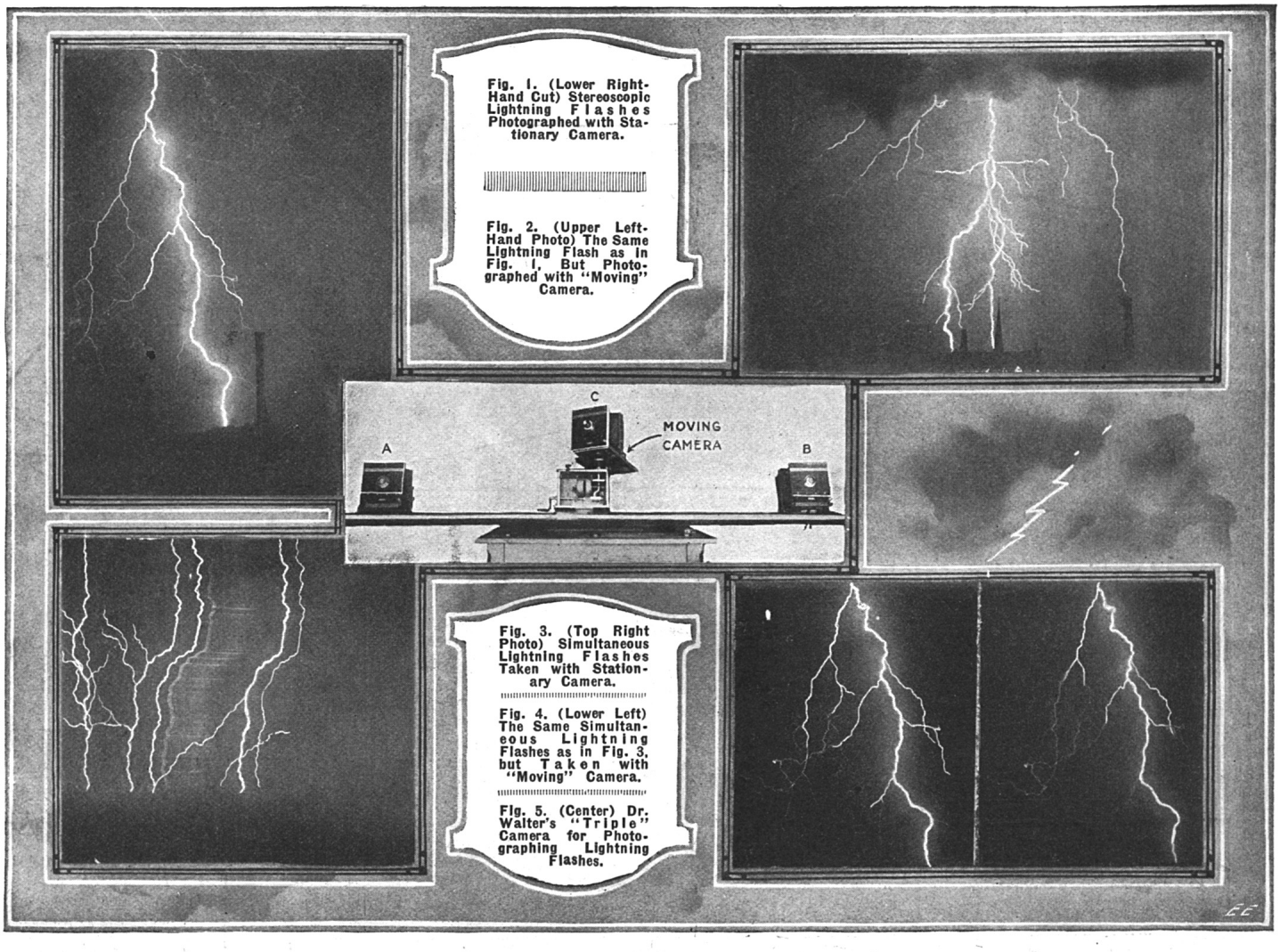


Fig. 1. (Lower Right-Hand Cut) Stereoscopic Lightning Flashes Photographed with Stationary Camera.

Fig. 2. (Upper Left-Hand Photo) The Same Lightning Flash as in Fig. 1. But Photographed with "Moving" Camera.

Fig. 3. (Top Right Photo) Simultaneous Lightning Flashes Taken with Stationary Camera.

Fig. 4. (Lower Left) The Same Simultaneous Lightning Flashes as in Fig. 3, but Taken with "Moving" Camera.

Fig. 5. (Center) Dr. Walter's "Triple" Camera for Photographing Lightning Flashes.

Triple Camera Photos Lightning Flashes

By DR. ALFRED GRADENWITZ

EVEN those photographs of lightning flashes by Night which, as far back as about 40 years ago, were made with ordinary stationary cameras, would in some cases give evidence of the complex nature of the phenomenon of lightning, made up of several successive discharges following up one another by jerks and, as a rule taking the same course thru the air. With some of the very first photographs of this kind, a strong wind would drive the air particles on the path of the lightning flash so rapidly in front of itself, that the successive discharges passing one *after* the other thru the same were reproduced in the space *beside* one another on the photographic plate. This suggested the idea of analyzing the lightning flash, even without the intervention of the wind simply by imparting to the camera a convenient motion. The first photographs of this kind were made by Prof. Weber, of Kiel, who simply held his camera between his two hands, thus imparting to it a slow oscillating motion and causing its optical axis to describe a conical surface.

THE MOVING CAMERA FOR LIGHTNING PHOTOS.

This method was eventually improved upon by Prof. B. Walter, of Hamburg, who by placing the photographic camera on a convenient clockwork, caused it to perform a very slow rotation around a stationary axis. The distance between the individual discharges on the plate, allowed the time interval passing between them to be calculated. By systematically developing this method, Prof. Walter provided a ready means of submitting any lightning flash to an accurate *time analysis*, which was one of the greatest advances ever made in this branch of physical science.

The most striking feature of the lightning photographs reproduced in the accompanying figures is that the appearance of the flashes, as a rule, is quite unlike the traditional *zigzag* figure, and rather resembles a large river as it appears on a map; branching out on both sides at irregular intervals and allowing (in the original photos) even the tiniest branch discharges to be detected.

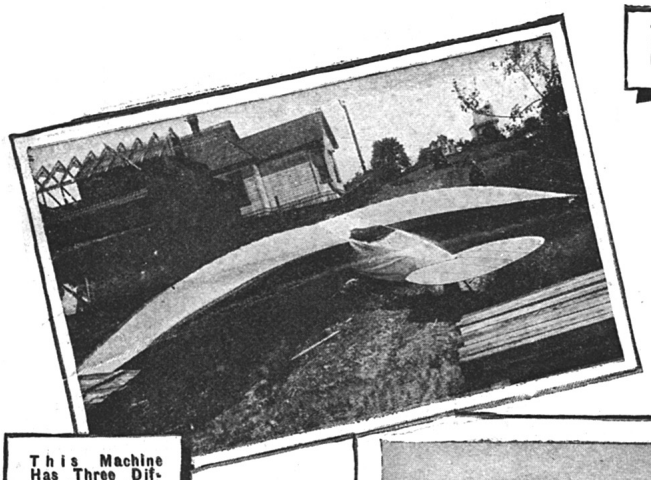
THE ADVENT OF THE TRIPLE CAMERA.

Another important step forward was made when Walter, some years afterwards, hit upon the idea of combining his moving camera with a set of two stationary cameras arranged at the ends of a table 4 meters long, in the center of which the moving camera was placed. The pictures obtained with the two stationary cameras would, when glued on pasteboard beside one another, *constitute a stereoscopic picture.*

Stereoscopic lightning flash photographs, Figs. 1-a and 1-b (lower right-hand cut), *allow the distance of each lightning flash from the observer to be ascertained.* Furthermore, each of these pictures in conjunction with the third one, viz., the picture obtained with the movable camera (Fig. 2), will give any time difference between the various discharges. On the other hand, the two pictures obtained with the stationary camera, provided the distance between the latter bears a proper ratio to the distance of the lightning flashes, are very well adapted for stereoscopic inspection and this brings out some further interesting facts about the constitution of lightning flashes. In fact, on examining Figs. 1-a and 1-b in the stereoscope, those branches, which in each individual picture cross one another, *are seen to be entirely separated in space,* and accordingly, *to be entirely independent branches of the main flash!* Stereoscopic inspection also shows that in the present case, far behind the strongest left-side ramifications of the main flash, another self-contained flash of lightning has occurred whose origin in the cloud is readily found, which has turned to left in order, it seems, to terminate in another cloud. From the dimensions of the original picture, the distance of the main flash of lightning from the observer is found to be about 500 meters, and that of the flash of cloud lightning several kilometers. That the latter really is a discharge entirely independent of the main flash of lightning is, by the way borne out by the third picture of the phenomenon, the one obtained with the moving camera (Fig. 2), the main flash of lightning being practically instantaneous, while the cloud lightning is made up of two partial discharges, with maxima following up one another at 0.0905 second interval.

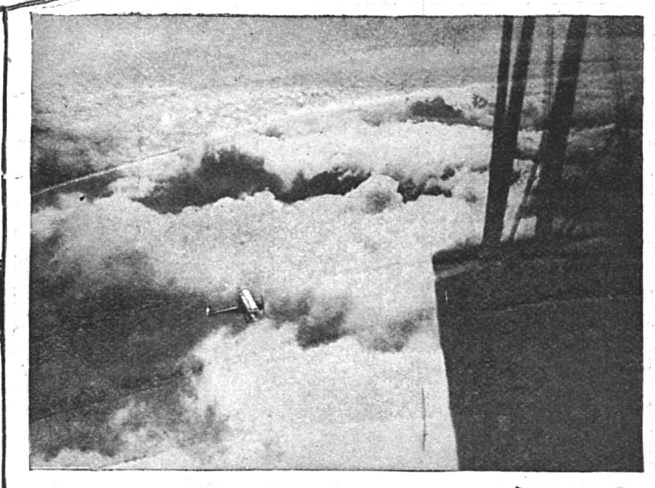
(*Continued on page* 346)

Freak Airplane Photos



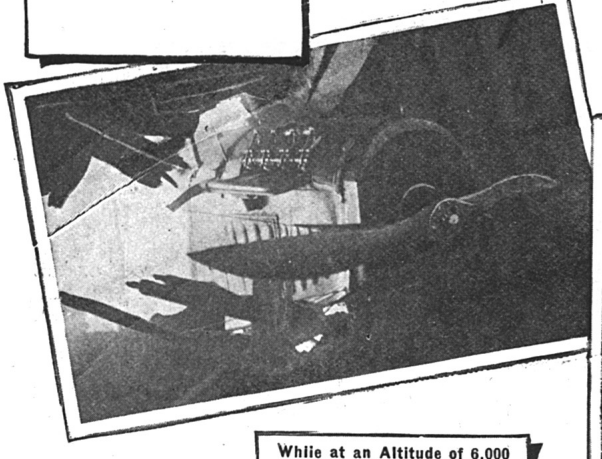
This Machine Has Three Differently Inclined Surfaces with respect to Each Other, in Such a Way That They Can Be Varied According to the Air Resistance and the Center of Gravity.—Photo by P. A. Wall.

This Is the Result of "Pancaking," When Landing. Note How the Undercarriage Has Been Driven from Under the Fuselage.—Photo by Edwards.

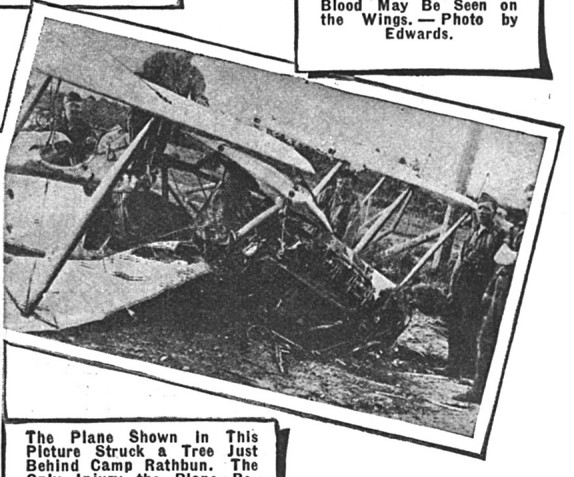


This Photo Was Taken on a Dark and Cloudy Day, and Shows How Bright It May Be Above the Clouds Altho a Storm Is Gathering on the Plains Below.—Photo by Edwards.

This Plane Tried to Enter a Hangar "Thru the Roof," but Stuck When Part Way Thru. —Photo by Edwards.

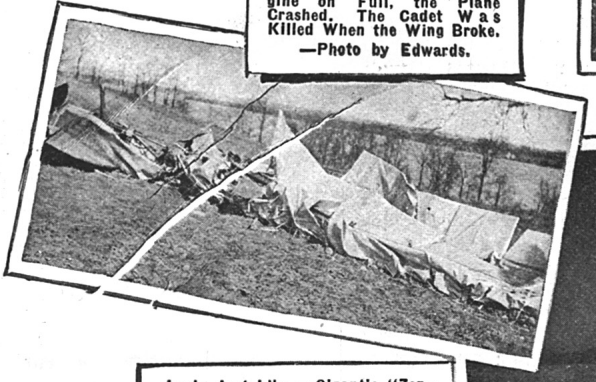


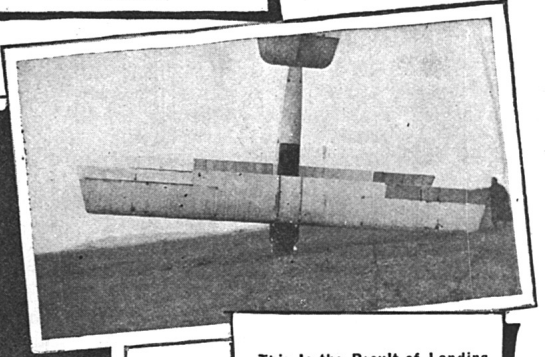
This Is a Bad Crash and Shows What Happens to the Man in the Front Seat When a Plane Crashes. In This Case, the Man Was Killed. Blood May Be Seen on the Wings. — Photo by Edwards.

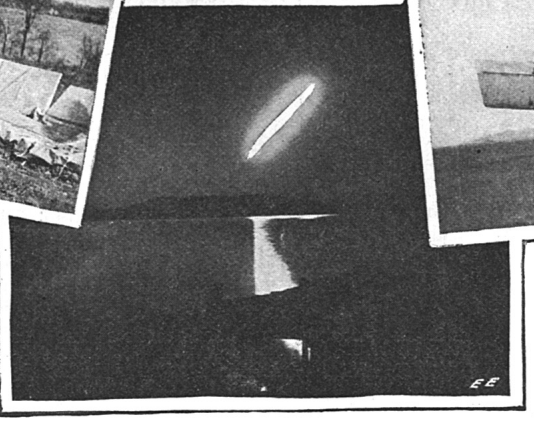


The Plane Shown In This Picture Struck a Tree Just Behind Camp Rathbun. The Only Injury the Plane Received, Was a Hole Thru a Lower Plane. The Pilot Came Down on a Rope.—Photo by Edwards.

While at an Altitude of 6,000 Feet, One Wing of This Plane Broke Off and with the Engine on Full, the Plane Crashed. The Cadet Was Killed When the Wing Broke. —Photo by Edwards.







Looks Just Like a Gigantic "Zeppelin" Illuminated at Night and Sailing Over the Lake, Doesn't It? Well, It Is Not a Photograph of a Comet nor a Zeppelin After All, but Simply the Result of a 35 Minute Exposure of a Beautiful Moonlight Scene Taken on a Small Lake. — Photo by George H. Walter.

This Is the Result of Landing When the Nose of the Machine Was Down. The Planes usually turned completely Over, but This One Was Rather "Self-Balancing." — Photo by H. Edwards.

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The T-Tube "Sub" Locator

Photo by International Film Service

An Invention That Promises To Be of Inestimable Value in Naval Warfare Has Been Made Public by the Navy Department. It Is Called the M. V. Type Hydrophone. With This Device It Is Possible to Detect and Locate Enemy Vessels and Icebergs Within a Radius of 100 Miles.

Photo by Underwood & Underwood

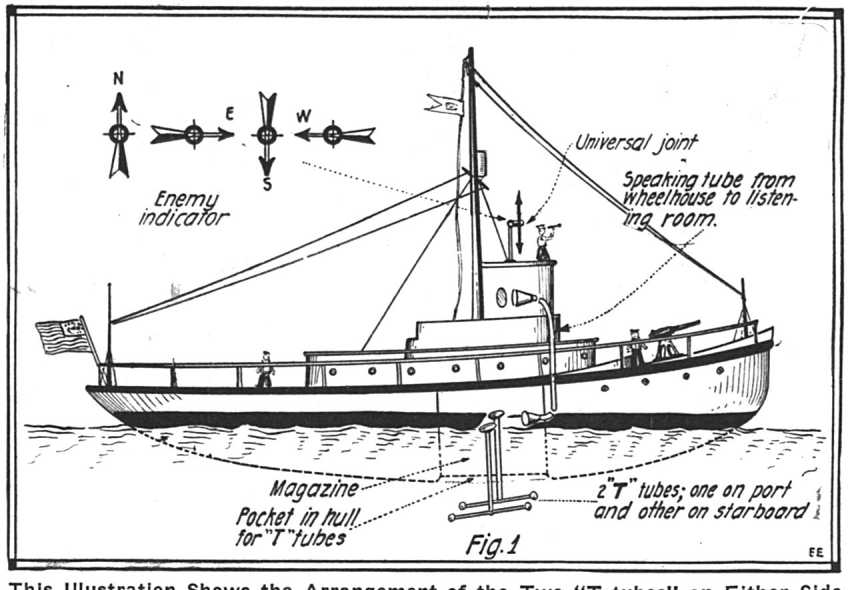
Actual View of "T-tube" Operator in the Hold of a Submarine Chaser Listening for Enemy Submarines Which Are Detected by the Sound Produced by the Rotation of Their Propellers. One Tube on Either Side of the Boat Leads to the Right and Left Ears, Respectively.

How the Fate of Doomed Submarine Crews Were Ascertained by the Use of a Simple Mechanical Device

THE "T" Tube, also called the "C" tube by naval men, was installed on every submarine chaser forming squadrons which operated in the Submarine Zone. These "T" Tubes were in reality a very simple device making use of sound waves. Two individual "T" Tubes were installed on each ship, one on the port side, and one on the starboard side directly under the wheel house in the ship's magazine as shown in Fig. 1. Two operators were constantly on watch, even while under way.

The "T" Tube itself consists of a long tube not unlike an inverted "T". By studying Fig. 2 it will be noted that on each end of the extended arm are rubber balls fitting tightly on the tube and watertight. Any slight sound in the vicinity of the ship causes minute depressions against the ball, and these slight deviations are accurately reproduced in the listening operator's ear by means of a sensitive device identical to the stethoscope. Normally, the air pressure on the operator's ear is 15 pounds per square inch on each ear, and the slightest pressure or vibration upon either of the rubber balls causes a slight increase of pressure on the one or the other of the listening operator's ears. By swinging the "T" around by means of the operating wheel shown in diagram, the operator is able to swing both ends of the "T" in such a position as to secure maximum reproductions of the sound waves, until an equal intensity on both ears is obtained. Having accomplisht this procedure, it is then an easy matter for the operator to note the position of the "T" in respect to the bow of the ship and thereby read the general direction of the sound waves.

The other operator of course follows the same procedure as the first and the position he secures is plotted against the other, so that the point of intersection of the two general lines gives the approximate spot from which the sound is issuing. In other words both "T"s are used jointly for the purpose of "checking up." Fig. 3 illustrates the general manner in which this "checking up" is accomplisht.



This Illustration Shows the Arrangement of the Two "T-tubes" on Either Side of a Submarine Chaser, Together with Semaphore Arrow for Indicating the Position of the "Enemy" to Other Vessels in the Pursuing Fleet.

It will be seen from the above description that the "T" Tube depends entirely upon the principle of an easily applied acoustic arrangement. Sensitive electrical sound amplifying devices were used, even vacuum tube amplifiers were brought into play in an attempt to increase the sensitiveness of the "T" Tube, but without any great success, as it was found that it operated best with variations in air pressure alone.

The device, of course, could only be used when the ship was at full stop and all members of the crew and machinery at a standstill. Another instru-

(*Continued on page* 331)

New Suspended Monorailway

WE have become so accustomed to see railroad trains, electric street cars, and elevated trains travel along on top of their rolling wheels,—that it comes almost as an electric shock to our imagination, perhaps, to consider for the moment, the suspended electric railway such as that shown on our front cover, and in the accompanying photographs.

With the rapidly mounting cost of building electric or other railways and also the higher operating cost from day to day, shortly, perhaps, be served with the very latest development in this unique and novel form of transportation, which is ideally adapted to the efficient movement of both passengers and freight.

Two of the accompanying photographs present views of the oldest suspended electric railway in the world, that of the Langen type operated at Elberfeld, Germany, known as the Barmen-Elberfeld Monorailway, which has been in operation over its 8½ mile run, since March, 1901, or nearly 20 years. This line has proven very successful and cheaper than any other form of transportation in its lengthy period of operation. This line is now carrying about 10,000,000 passengers every year, and it has carried a total of well over 150,000,000 passengers, with not a single passenger or employee injured or killed during the entire extent of its operation.

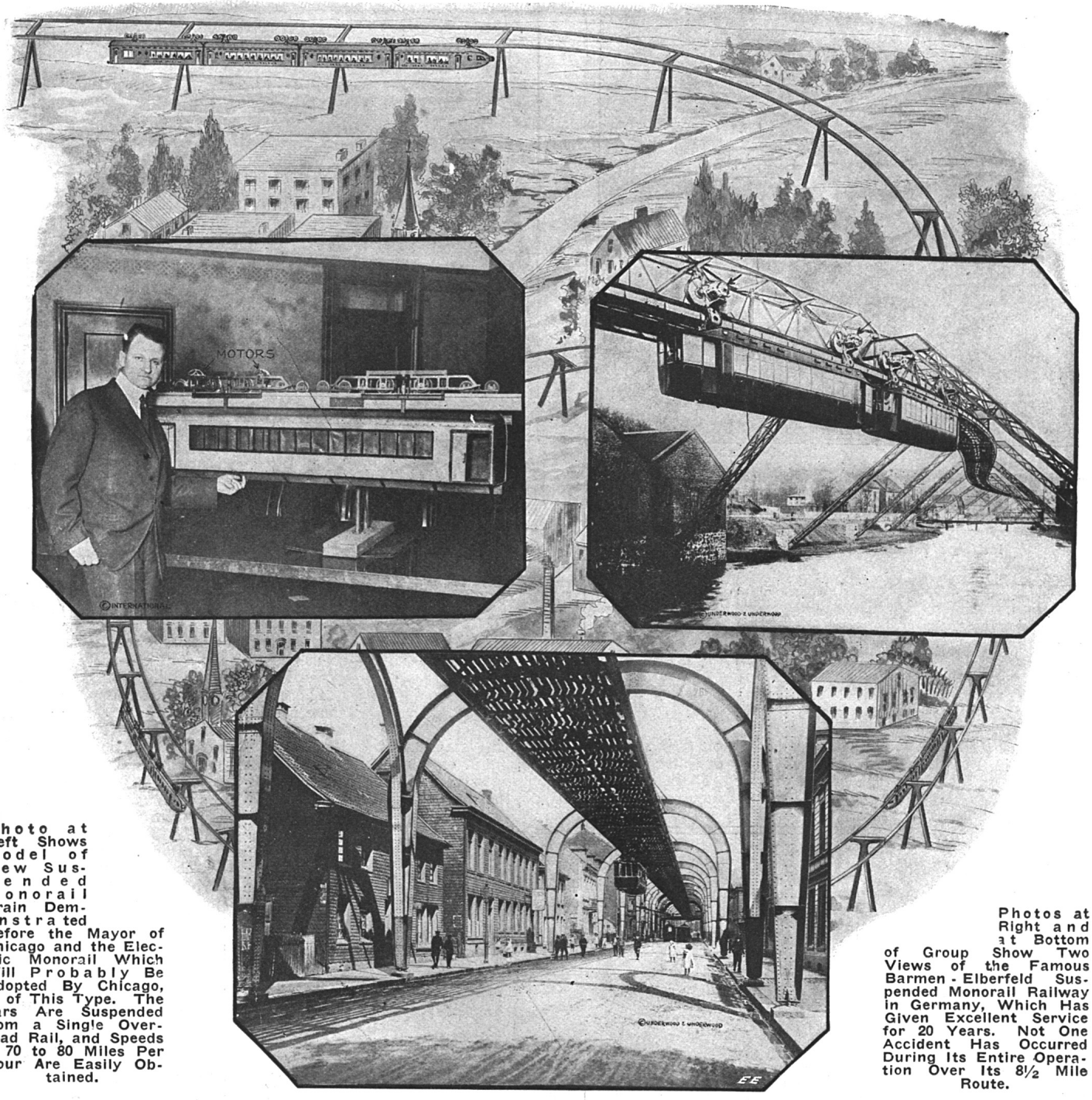


Photo at Left Shows Model of New Suspended Monorail Train Demonstrated Before the Mayor of Chicago and the Electric Monorail Which Will Probably Be Adopted By Chicago, Is of This Type. The Cars Are Suspended from a Single Overhead Rail, and Speeds of 70 to 80 Miles Per Hour Are Easily Obtained.

Photos at Right and at Bottom of Group Show Two Views of the Famous Barmen-Elberfeld Suspended Monorail Railway in Germany, Which Has Given Excellent Service for 20 Years. Not One Accident Has Occurred During Its Entire Operation Over Its 8½ Mile Route.

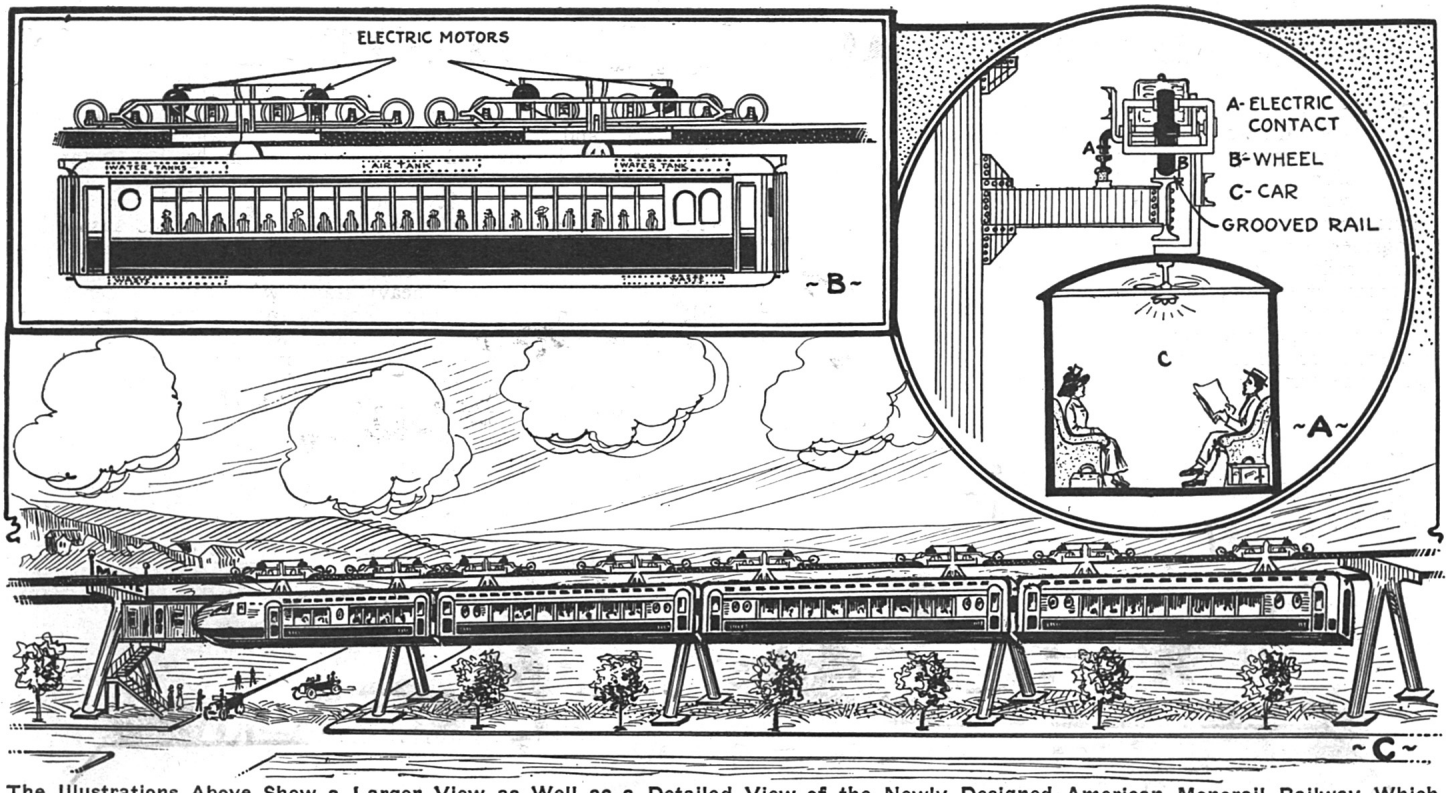
American engineers who have been endeavoring to solve some of the tremendous traffic problems of the great city of Chicago—the "Gate-Way to the West"— have found the advantages of the electric monorail, with suspended cars as here shown, worthy of their most earnest consideration. The photographs herewith show in a vivid manner, just why the monorail of this type has made such an impression on American engineers; in fact so much so, that the city of Chicago and its environs will very

OUTSTANDING FEATURES

Looking at the accompanying photograph, one will see that there are indeed a great number of revolutionary features possest by this system of railroading which are not to be found in any other form of rail transportation. Among the advantages of particular prominence, we find:

1: A medium weight train can be operated at high speed over the suspended monorail system with the same stability as at present obtainable only by the use of very heavy trains with their low center of gravity. The big point here, is that with our heavy trains, we continually need more horse-power to move them, and more speed means more weight. This is not the case with the suspended monorail train, it being possible to operate it at from 70 to 80 miles an hour with only medium weight in the cars, necessitating, therefore, only a fair amount of horse-power in the electric motors to propel the trains.

It may be said here, that the system of propulsion is very simple, the electric current being taken from a so-called third-rail, which is nothing but an insulated bare electric conductor, mounted either on top or at the side of the steel I-beam track, on which



The Illustrations Above Show a Larger View as Well as a Detailed View of the Newly Designed American Monorail Railway Which It Is Proposed to Adapt in Chicago and Environs to Help Relieve the Severe Traffic Congestion in Chicago. Instead of Using Grooved Wheels on Which to Suspend the Cars, Crowned Wheels Travel Along in Circular Grooves on Top of the Rail Beam. The Arrangement of the Third Rail and Contact Shoe Is Also Clearly Shown.

the wheels carrying the weight of the suspended cars travel.

In the newly proposed American form of suspended monorail, the wheels from which the cars hang, instead of being fitted with a flange as in the Langen or foreign system, are designed to travel in a deep circular groove, formed in the rail on top of the I-beam track structure, as one of the accompanying illustrations clearly shows. This illustration also shows the arrangement of the third-rail shoe thru which the current is taken, and after passing thru the motors, it then flows thru another wire and out thru the wheels to the rail on which the cars are suspended, and back again to the power house.

2: The second big feature of the suspended monorailway is that there are no *grade crossings,* and also with the highly perfected electric interlocking block system now used, improved signals, etc., there is practically no danger whatever from rear-end collisions or head-on collisions between trains on this system.

3: Due to the peculiar mechanical features involved in this system, the cost of giant bridges crossing rivers, chasms, etc., is reduced to one-half or one-quarter the usual cost. Instead of erecting a massive bridge containing perhaps 1,000 tons of steel with wood flooring and cross ties, etc., all that is required to carry the monorail trains over a considerable span of river or chasm is a single, well-supported steel girder, as our front cover shows.

On the average run along land, the columns supporting the monorail track would be placed about 100 feet apart.

4: The maintenance cost of the suspended monorail is only about 25% of what it is on our steam and electric railways and the operating expense can probably be reduced to about 50% of the present value, in order to handle the same amount of traffic, either passenger or freight. It is also figured that about 25% of the present accidents, which are always a large expense conundrum for railroad lawyers to settle annually, will be eliminated entirely by the beautiful simplicity of the suspended monorail train, as it speeds along with airplane velocity over country roads, brooks and even cities, as in Germany.

5: Snow, washouts, or other forms of natural impediments which arise now and then to interfere with the operation of both steam and electric railway trains, as well as street cars or trolleys, do not affect the monorail of the type here illustrated. They hold no terrors whatever for the flying monorail train as it speeds along over the snow banks.

SUSPENDED MONORAIL TRAINS OPERATE SMOOTHLY AT HIGH SPEED

In the Barmen-Elberfeld Monorailway, the trains operate at speeds varying from 22 to 35 miles per hour, but in the newly proposed American system, such as that which Chicago is contemplating installing in order to relieve the severe traffic conditions now prevailing, the speed, at least on suburban runs where the train is given a chance to gain headway, may easily be raised from 70 to 80 miles per hour.

Engineers who have investigated both the Langen and the proposed American system believe that these higher speeds could be reached not only with very safe running conditions as regards curves (and by the way, these trains do not have to slow down on curves at all), but also these suspended trains could be speeded up to these higher velocities at a reasonable and highly efficient operating cost. This is directly the opposite with the modern steam and electric railway systems such as we have in operation today, as when speeds of 80 miles an hour are desired, we obtain these velocities only by utilizing extra heavy locomotives and coaches, which become quite necessary in order to cause the train to hold itself on the rails and also to aid in giving it a low center of gravity.

The law of design of the modern steam engine gives the key to this situation at a glance. If you want a certain traction exerted between the driving wheels and the rails then what you get, is a certain percentage or about one-fifth or 20 per cent. of the load placed on the engine drivers. Thus, with a 600,000 H.P. engine, a traction of about over 80,000 to 100,000 pounds may be attained. With the monorail, all the weight is centered on the overhead wheels, and as can be readily seen, even by the lay man, this downward tractive effort is high indeed, which obviates any extra loading of *useless, dead weight,* as is the case with our modern railway systems, into the railway cars and engines in order to obtain the necessary stability at high speeds.

DETAILS OF ROLLING STOCK

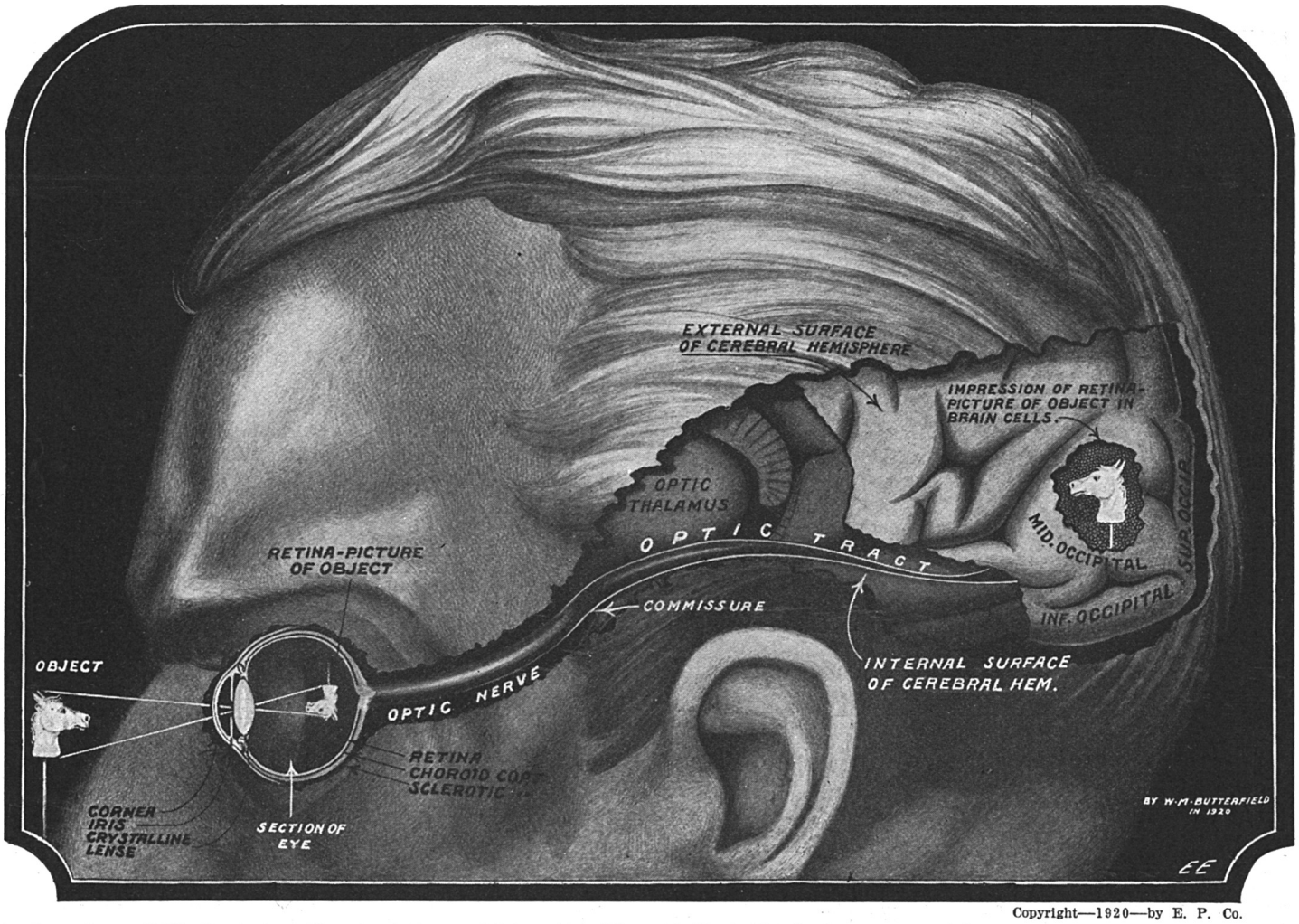
One of the accompanying photographs shows a model of the proposed American type of suspended monorail cars, as demonstrated before the Mayor of Chicago and engineers connected with the city government.

As will be seen, the track and wheel arrangement on top of the car by means of which the passenger carrying compartment is suspended, is entirely different from the German type. Instead of having but two wheels driven by an electric motor as in the Langen type of car, the new model involves the use of a series of wheels,—six on each truck in the present case, the advantage of this arrangement being, as the engineers have pointed out, that the load is more evenly distributed over a track span, equal to the length of the car itself.

In other words, the two trucks with their 12 wheels for each car, will be distributed over as great a length approximately as the car itself. This works out advantageously in many ways, and it is one of the big items that reduces the estimated cost of the American system to less than one-half that of the Langen system. This is so because there is much less steel required in the rail structure for one thing. Again, there is a markedly greater traction manifested between the wheels and the rail, with a consequent greater grade climbing ability, than is the case where but two wheels or even four for the car, is used, as in the Elberfeld railway.

Of course, the cars are fitted with Westinghouse air brakes and all the other niceties of modern electric railroading.

The coaches for this class of service are constructed of steel and are to be just as comfortable and luxuriously furnisht as the best cars operated by the steam railroads. It is understood that in the German system there is considerable noise at times, especially when the cars run around sharp curves, due to a "squealing" of the wheels, but in the American system this slight objection, as we might really call it, is to be eliminated, as these trains *operate entirely noiselessly.*



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In Accordance With the Latest Theory of Human Vision, It is Thought That We Actually "See" by Electrical Means. The Rods and Cones in the Retina of the Eye Correspond, It Seems, to Selenium or Photo-electric Cells. Thus When Different Gradations of Light Impinge Upon Them, They Cause Currents of Varying Strength to Pass Along the More Than 2,000,000 Fibers Comprising the Optic Nerve, Like the Wires in a Telephone Exchange, to the Proper Sight Cells in the Brain, Energizing Them.

Do We "See" Electrically?

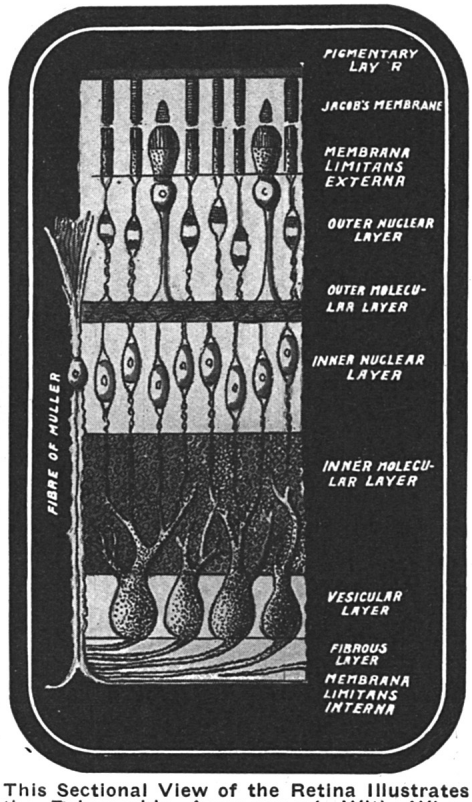
By H. WINFIELD SECOR

Associate Member, American Institute of Electrical Engineers

THE interesting article—"Is Life Electrical?" by Prof. Rusk, in this issue, prompts the illustration and theory presented herewith, of the human eye and the optic nerve, which connects it with the *sight center* of the brain, lying at the rear of the organ of thought.

The study of physiology opens up whole worlds of unbelievable *magic,* yet most of us wander along thru our daily lives not paying any particular attention to the various bodily functions and organs. We hear, smell, taste, feel and SEE, not thinking for a moment as to how we actually do these things! At some later date, we hope to present some recent theories and aspects of the other senses, besides that of *sight,* but for the present we will confine ourselves to this most wonderful of man's endowments.

As to *how* we see, there is this much to say: The image on which the eye is focused is carried into the inner chamber of the eyeball thru the iris and crystalline lens, as our physiologists teach us. Here, a most unique phenomenon takes place, viz: the image is cast upon the retina of the eye in an *inverted* manner. If the function of seeing performed all its operations at this juncture, we would naturally see houses, trees and other objects, upside down! But here is where *part* of the great mystery of sight begins—a mystery which some of our greatest physiologists have not as yet unravelled. The action in the eyeball is only the *beginning* of sight!



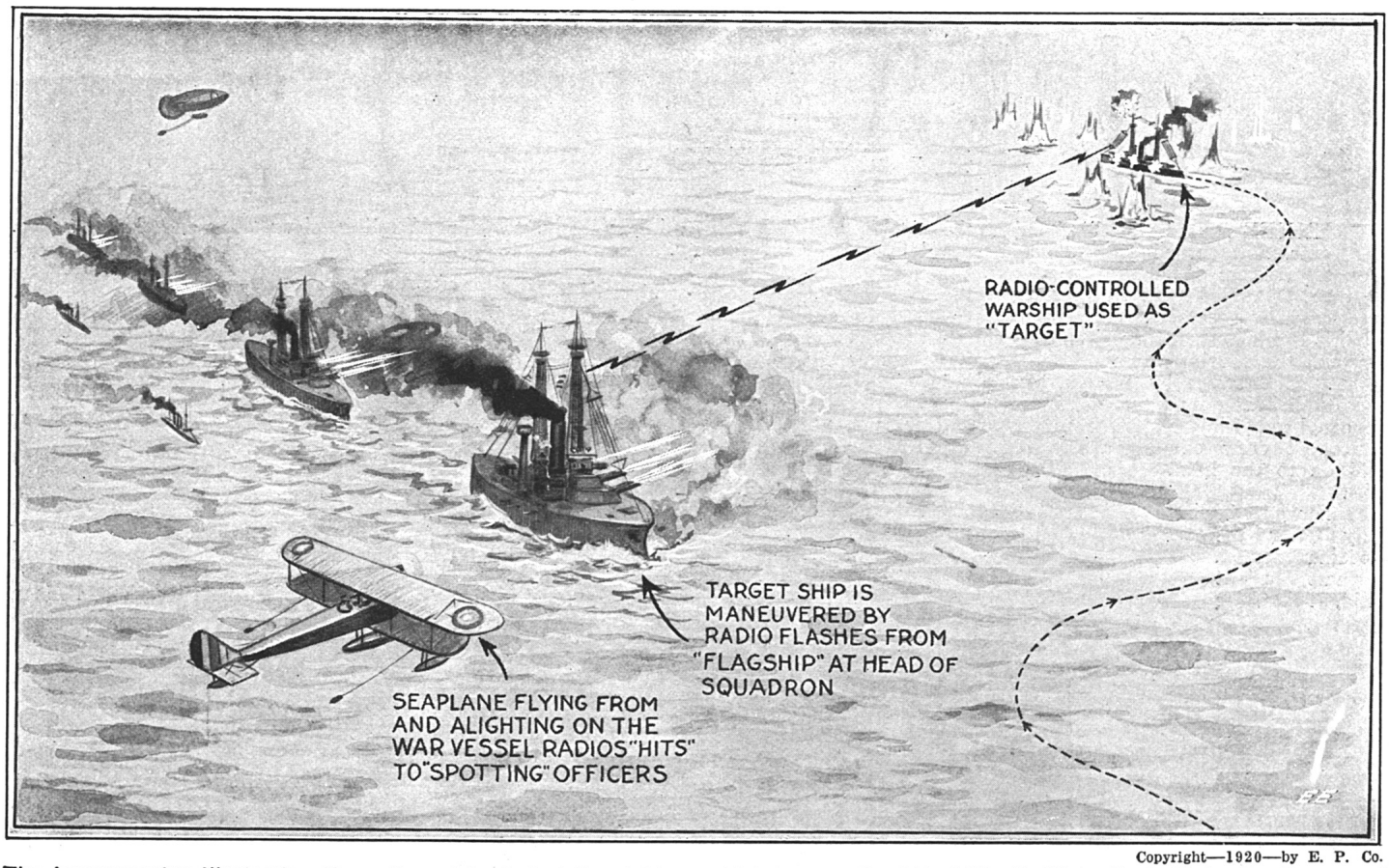
This Sectional View of the Retina Illustrates the Telegraphic Arrangement—With Wires (Fibers) Connecting Retina and Brain.

The light and shade values of the image cast on the retina, fall on a series of what are now supposed to be minute photo-electric cells, covering the rear inner-hemisphere of the eyeball and there are over 2,000,000 of these cells or rods and cones, as the physiologist calls them. Each one of these light-sensitive cells connects to one of the more than 2,000,000 fibers constituting the *optic nerve,*—the great nerve of sight, which passes up thru the head to the rear of the brain or region of sight. The hundreds of thousands of optic nerve fibers, each corresponding apparently to a fine electric wire in a telephone exchange, terminates at a certain cell in the brain. Thus when we see an image, a person's face, for example, there is simultaneously stimulated in the brain a complete pattern of particular cells; which probably reconstruct the image perceived. And the result is that we do not see the object we look at, upside down, but *right side up!*

It is now thought that when the various points of light pass thru the lens of the eye on to the rod and cone layer of the retina at the rear of the eye, that extremely minute electric currents are set up and pass along the respective nerve fibers (remember, there are over 2,000,000 of them) to the cells of sight located in the brain, and it is at this point where we interpret the image or picture which the eye beholds, and *not in the eye itself,* as is often popularly supposed.

In other words, if one should receive an injury at the top or rear of the head in

(*Continued on page* 310)



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The Accompanying Illustration Shows One of the Latest Naval Ideas Which Invokes the Aid of "Radio Wave Control" for the Purpose of Maneuvering a Target Ship Over a Circuitous Course. By This Means The Gunnery Officers in Charge of the Test Can Control the Target from the Flagship of the Squadron. The Range In Actual Practise Is, of Course, Much Greater Than Would Appear from the Illustration, as the Ship Cannot be Shown Large Enough Over any Great Range in a Picture Like This.

Radio Guides Ship Target

Unless plans of naval experts fail the old battleship *Iowa*—in its day pride of the American fleet and flagship of the late "Fighting Bob" Evans—will be used as a moving target for modern dreadnoughts, its movements directed by powerful wireless apparatus.

The *Iowa* is about thirty years old and is of no further use as a fighting machine. The "shooting up" of the veteran battleship, therefore, will be a slight loss to the navy. On the other hand, by sending the *Iowa* out to sea under wireless control and maneuvering the vessel as if she were in battle with our more modern ships, valuable data will be accumulated for future naval use.

Most targets of this kind in the past have been fixed. Targets also have been towed by other ships at the end of long cables. But a target moving under such conditions furnishes only a minimum of action. If plans work out as the experts expect, the *Iowa* will move around as if she were under her own steam with a full crew.

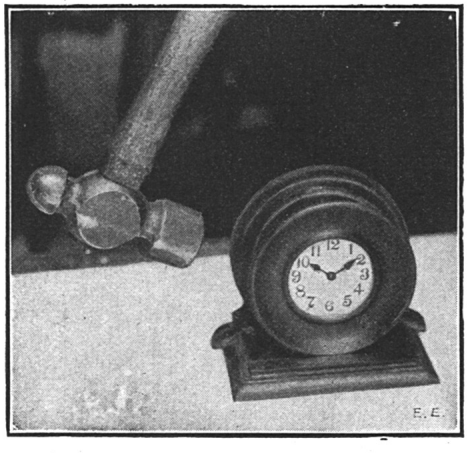
The contrivance to be employed in the experiment is that of John Hays Hammond, Jr., for the wireless control of torpedoes from land, with some modifications. For example, it is probable that the movements of the *Iowa* will be controlled not from shore but from a warship.

Other radio experiments are also under way. The battleship *Ohio* has been fitted with new and powerful wireless instruments and during the next few weeks will engage in extensive experiments. Other nations are working along this and other lines. In fact, radio promises to become more and more important in future warfare on both land and sea.

After the armistice the War Department allowed it to become known that the army had perfected radio control of airplanes and had sent them as far as 100 miles.

Shock-proof Rubber Clock

One of the latest advances in the world of clocks, is the new travelers' or desk clock,—a neat, inexpensive as well as decorative contrivance, to say the least.



This Rubber Clock Will Stand All Kinds of Knocks and Falls. Great for Travelers.

This novel clock is enclosed in a flexible rubber case which muffles the ticking of the clock to a great extent, and in the event of a fall, absorbs the effect of the shock, preventing injury to the glass and works. On actual test, when this shock-proof timepiece was thrown three feet to the floor, its working mechanism was in no way damaged, thereby demonstrating its efficacious merit.

One of the special features of the rubber casing is that it constitutes the entire ornamental superstructure of the clock, thus eliminating what would otherwise be a bulky addition.

Owing to its shock absorbing qualities, this clock can be mounted on movable machinery, in automobiles, motor boats, trains, airplanes, etc., and in fact can be used to advantage any place where vibration and shock would deter the accuracy of the ordinary time-piece.—ROSE HARRIS.

Ironing Hats by "Juice"

The Old Panama Hat Is Dampened and Ironed, and Its Pristine Shape Is Brought Back in Jig Time—Thanks to the Electric Iron. Photo by Edna Purdy.

Alarm Number 18

By CHARLES S. WOLFE

FENNER paused with his hand on the gate, and turned an interested face toward the oncoming juggernaut. I, too, watched with lively interest the exciting spectacle.

With wailing, shrieking siren and clanging bell, the roaring fire truck bore down on us. She swept by with a deafening staccato bellow of unmuffled exhaust, and we caught a glimpse of the nimble, rubber-coated crew clinging with precarious hold on to the hand rails.

Fenner gazed wistfully after the speeding demon. "I guess I'm just a kid, at that," he laughed, whimsically. "Whenever I see one of those babies burning the breeze I just want to run after her."

"Same dog bit me," I admitted, cheerfully, "I still get a lot of thrills out of a fire."

"Oh, well," Fenner's tones were rueful, "We can't go, because it's not dignified for big boys to tag after chemical engines. Let's get up stairs and give that circuit a hitch."

"Let's," I agreed, the spell of the clanging gong still on me, and we moved listlessly into Fenner's house.

As we mounted the stairs to the rooms that housed Fenner's wireless outfit, he remarked reflectively, "Insurance rates will be going up in this burg if we're not careful. Seems to me that makes about umpteen times that fellow's beat it by here in the last couple of days. If things continue like this, we will be enjoying a firemen's strike presently."

"Oh, well," I returned, carelessly, "Let 'em earn their money. Let's see that diagram."

Fenner tost me the blue-print, and I fell to studying the "hook-up" we were about to try out. Engrost, I paid little heed to the ringing of the 'phone bell, being vaguely aware that Fenner was answering the call.

I was aroused by a tap on the shoulder. I glanced up to find the scientist-detective grinning at me mischievously. "Put away the dope sheet, Bill," he laughed. "We are summoned to the throne room."

"Throne room," I echoed, blankly, "What's the large idea?"

"His Royal Highness, Chief of Police Davidson commands us to a séance at the Hall. Guests will please appear without side arms, and are to refrain from shooting crap with the plain clothes men" bandied Fenner, "Trot along, Bill, and watch the Big Boss sputter."

"Why sputter?" I asked, as I prepared to accompany my friend.

Fenner grimaced. "He sounded like 'static' in that 'phone," he said, "I was afraid he'd jar out the residual magnetism. Something has evidently gone aglee with the machinery down there, and Davidson thinks he sees a job for me. He seemed in a hurry. Guess we'd better take a trolley."

We hastened to the street, and caught a down town car. Fenner continued his stream of persiflage all the way down, and we were both laughing as we entered Davidson's office.

It took but a glance to tell us that Davidson was indeed angry. He glared at us from over his desk savagely, and hurled his unoffending cigar at a nearby cuspidor. "This thing has got to stop," he bellowed, shaking his burly fists at us in a threatening manner.

The jesting retort died unspoken on Fenner's lips. We realized that the chief was in no mood for chaff. He was in a towering rage.

"What's the matter?" queried Fenner, giving me an eloquent glance, which, by the way, was totally unnecessary. I have no desire to fool with buzz saws.

"Matter?" howled Davidson, "Some one's going to find out what's the matter. Believe me, if I get my hands on this cuckoo he's going to think it's resurrection day."

"What cuckoo, Chief?" asked Fenner, patiently.

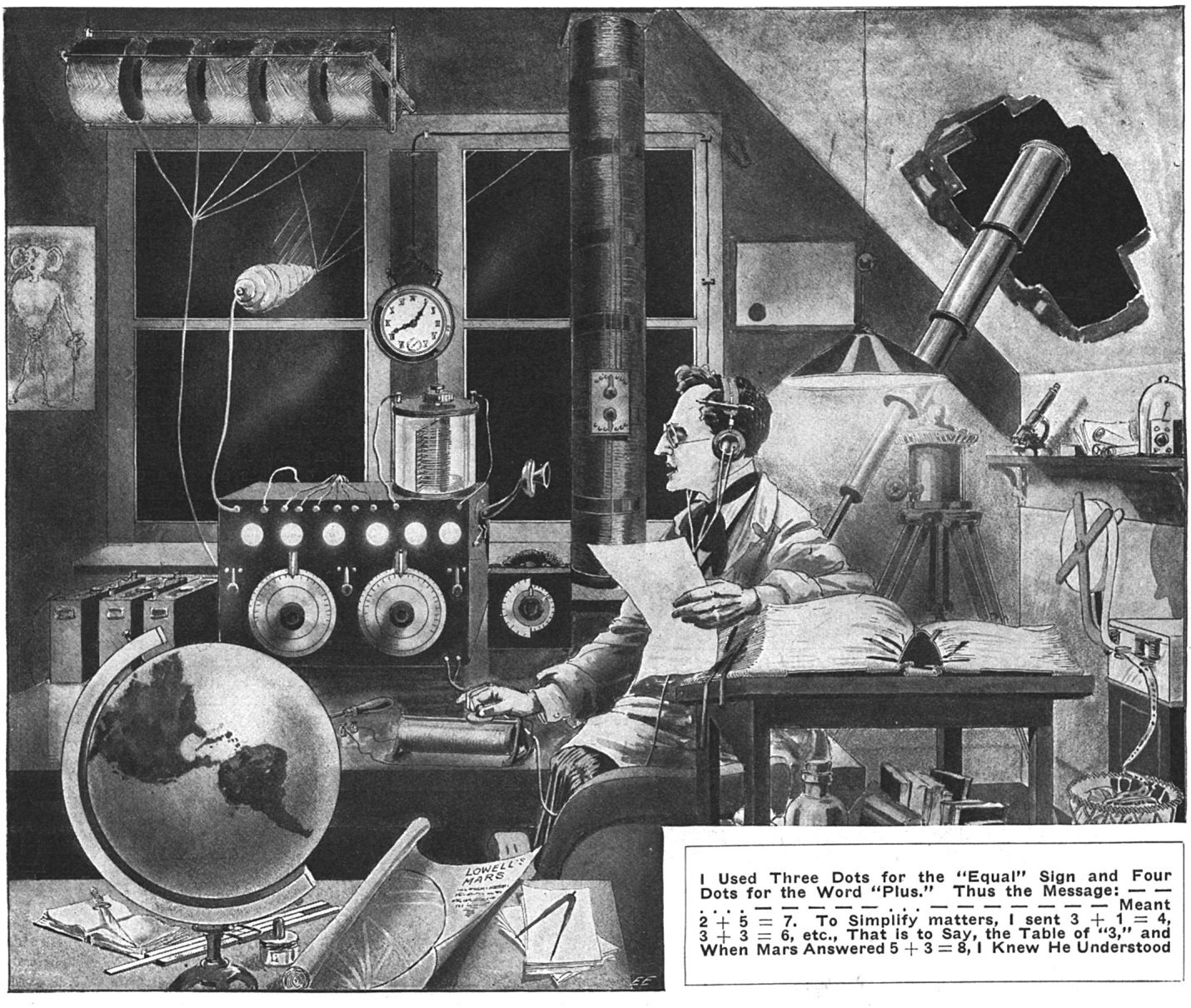
"The cuckoo that thinks the city fire alarm system is a plaything," yelled the infuriated police head. "Look! Look at this!" He waved a typewritten sheet under our noses, "Eighteen alarms of fire in forty-eight hours, seventeen of them false. Oh, some yap thinks he's brilliant, all right, but he's riding to one devil of a fall."

Fenner whistled interestedly. "What particular box do these fake alarms come from?" he queried, mildly.

"From no particular box," snapt Davidson. "One time it's a box over in the west end, next time it comes from the northern section. Then you get one in the business center. I'm getting tired of it, I tell you. This gang of Sherlocks I've got around here are numb from the necktie up. One of them thought he had a clue. He took the rest of the pack over to box 15 and covered the territory for three blocks around it. Then while the whole mob of

(*Continued on page 335*)

". . . Suddenly the Quiet of the Neighborhood Was Broken By the Wailing Shriek of a Siren. A Clamor Arose Below Us in the Street, as With Bell Clanging and Siren Screaching, Number Eight Rolled By in Answer to An Alarm. Instantly the Youngster Was on His Feet and Was Leaning Half-Way Out of the Window. 'There She Goes,' He Yelled Over His Shoulder,—His Eyes Burning Feverishly, 'Oh, Lord, How That Fellow Does Beat It.' . . ."



I Used Three Dots for the "Equal" Sign and Four Dots for the Word "Plus." Thus the Message: — — . . . . — — — — — . . . — — — — — — — Meant 2 + 5 = 7. To Simplify matters, I sent 3 + 1 = 4, 3 + 3 = 6, etc., That is to Say, the Table of "3," and When Mars Answered 5 + 3 = 8, I Knew He Understood

My Message To Mars

By CLEMENT FEZANDIÉ

Explaining a simple method of teaching an intelligent Martian by wireless, to understand our measure of length, area, volume and weight, our time, our alphabet, and a working knowledge of the English language

CHUCK PETERS and I had spent weeks in preparing my wireless set in order to get it of sufficient power to send a message to Mars. At last all was ready, and for a week we had been sending out our call which consisted of three slow dashes repeated ten times. We kept repeating this call at intervals of exactly two minutes.

And then one day, while I was at the instrument, the answer came in a pitch that could not be mistaken for any wireless on earth. Mars—for it *was* Mars as I afterwards learned by ascertaining the direction of the waves—repeated my call. For a few minutes we amused ourselves by sending this call backwards and forwards. Then I proceeded to teach him our numbers. I sent one dash for the number one, two dashes for number two and in this way proceeded to count from one to nine. Then I began over again. Mars repeated the list after me. The fifth time I sent the list, I did not stop at nine but proceeded to twelve and to my joy Mars answered by counting up to *fifteen!*

It was a simple matter now to teach "Marty" (for so I called my new correspondent) simple sums in addition. I used three dots for the "equal" sign and four dots for the word "plus." Thus the message: ----.....----.....---------- meant 2 + 5 = 7. To simplify matters, I sent 3 + 1 = 4, 3 + 2 = 5, 3 + 3 = 6, etc., that is to say, the table of "3," and when Mars answered 5 + 3 = 8, I knew he understood that four dots meant "plus" and three dots meant "equals." I then sent simple examples: multiplication, using five dots for the word "times" and when Marty telegraphed 4 × 3 = 12, I knew he had caught on. Substraction and division I did not teach till later, tho they would have been just as easy to understand. From division I taught fractions: thus, one-half = 1 ÷ 2, and one-tenth = 1 ÷ 10.

To teach the word "zero" or rather the cipher, I wirelest: 4 + 0 = 4, 7 + 0 = 7, etc., and Mars soon understood.

Right here, I had to do what we often have to do in teaching, rub out all we had learned and start afresh. The system of numeration was getting too complicated when twenty-seven dashes were needed to express the number 27. So I taught Mars the continental code for the numbers. This knowledge of the equality sign served me here. I telegraphed: 3 = ...--, and when I had repeated all the numbers from 1 to 9, I made sure he understood the new code by sending him simple additions and multiplications using the continental code. Then I proceeded to count up to 99. Marty had a little difficulty at first, due, as I soon learned, to his using the *duodecimal* system of numeration, instead of our decimal system. That is to say, the Martians count by twelves instead of by tens. Then number 97 means nine twelves plus seven units or our number 115.

(*Continued on page* 318)

How to Talk With Mars

Of late we have heard and read much about talking with Mars. Suppose we DO send or DO receive signals. How can we make ourselves understood, or how do the Martians hope to make themselves understood? Hundreds of famous scientists are having a hot battle over the subject—and fail to agree.

The author of this article gives us a method written in a delightful vein, devoid of all technicalities. It's so good you can't fail to read it—you'll enjoy it thoroly—especially the little surprise.—EDITOR.

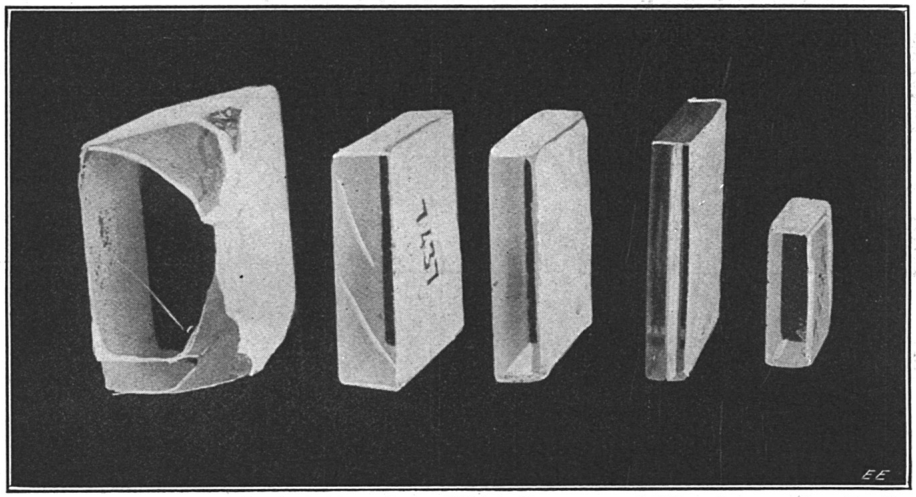
The Story of Glass

By PROF. FLOYD L. DARROW

The Glory of the Glass Maker Is Undoubtedly Reflected in the Large Telescope Lens, the One Here Shown Being One of the Most Perfect of Its Kind in the World, and Measuring 40 Inches in Diameter. The Reflection of the Man's Image at the Extreme Right Will Be Noticed on Close Inspection. Frequently a Great Many Batches of Glass Have To Be Run Off Before a Sufficiently Perfect Block of Glass from Which to Grind the Lens of This Type Is Obtained.

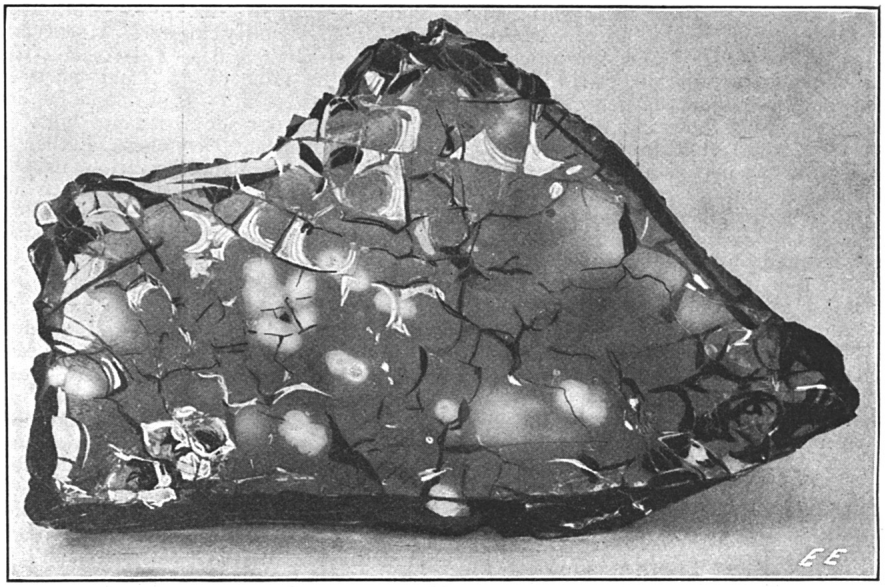
GLASS MAKING is one of the very earliest arts known to the human race. Its discovery antedates recorded history. Certain it is that for long centuries before the Christian Era, the Egyptians, Babylonians and even the Chinese had mastered the art of fusing the basic materials into glass and had acquired marvelous skill in blowing it. From Egypt this knowledge past to the Phoenicians and Greeks and later to the Romans and Central Europe. Necklaces and articles of ornamentation from ancient Egypt, at least six thousand years old, are to be seen in our museums, and window panes, buried for nearly twenty centuries beneath the ashes of Pompeii, have recently been excavated. The beautiful color effects in the stained glass windows of Old World cathedrals even point to the coloring of glass as something of a lost art.

But if the modern world must stand in awe before certain masterpieces an ancient art, it is equally true that the tremendous progress in the manufacture and working of glass, made during the last century, eclipses all that was ever done in all preceding time. Indeed, very much of our boasted present-day civilization would have been impossible without an abundance of glass and the multitudinous articles of commerce and instruments of science dependent upon glass for their manufacture. Did you ever stop to consider the innumerable points in which glass touches your life and enters into your well-being? If not, a brief review will convince the most skeptical of the very great debt he owes to the expert craftsmen engaged in this industry. Glass admits the light and genial warmth of the sun to your dwelling. In the form of chimneys, lamp bulbs and shades it diffuses the light from our artificial sources of illumination. The powerful silvered reflector of some coastwise lighthouse projects its beams across the harbor and guides your ship to a safe anchorage. The head-lights of your automobile are also made of glass. In the form of eyeglasses this wonderful substance corrects your erring vision and restores your dimming sight. In the camera it preserves familiar scenes and the faces of your friends in imperishable records of truth and beauty. And more, it makes possible the marvelous illustrations of modern books and magazines. In the projection lantern and the moving picture machine lenses of glass afford a countless host of individuals with a form of pleasure and recreation without a parallel. The X-Ray and all that it has meant to medicine and surgery would have remained forever undiscovered without glass tubes, at once impermeable to gases and transparent to light. Without lenses the telescope, and the spectroscope, those wonderful astronomical instruments which have so immeasurably increased our knowledge of the universe and broadened it to infinite dimensions, could never have been made. So too, the microscope, which, penetrating the universe in the opposite direction, has revealed systems of life and matter as truly marvelous as the infinite depths of space.



This Shows Blocks of Optical Glass from Which Camera and Other Lenses Are To Be Eventually Ground.

In the Great War immense quantities of glass became imperative for the making of range finders, gunsights, periscopes, searchlight mirrors, photographic lenses and binoculars. Go into a chemical laboratory and inspect the vast array of glassware essential to the analysis of the raw materials and finished products of chemical manufacture and then, if never before, you will appreciate the tremendous importance of glass.



A Block of Glass Which Has Undergone "Devitrification." The White Spots Represent Crystals of Wollastonite. Photo Courtesy of Geophysical Laboratory, Washington.

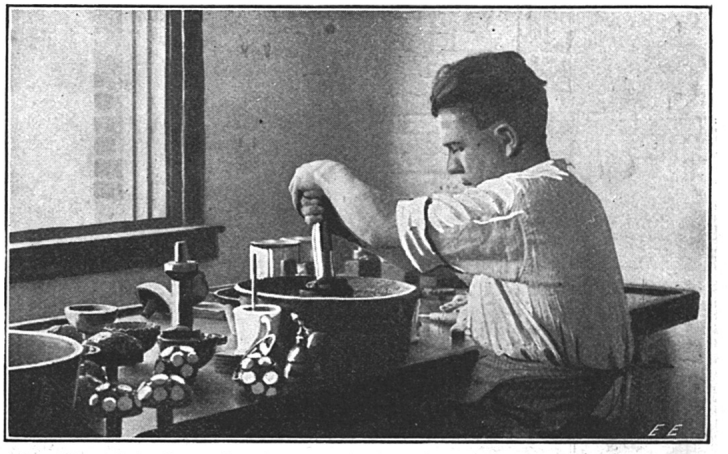
Glass is made from the commonest of materials and comprises three principal varieties—Crown glass, Bohemian glass and Flint glass. Crown glass is common glass. From it windows, bottles and plate glass are made and also some lenses. The ingredients that go into it are silica, or ordinary sand, lime and soda. Bohemian glass

This Shows the Older Method of Blowing Bottles, Incandescent Lamps and the Thousands of Other Forms of Glass By Blowing Them Into Shape While Hot. The Breath is Blown Thru a Tube Into the Glass, Causing It to Expand to the Desired Size.

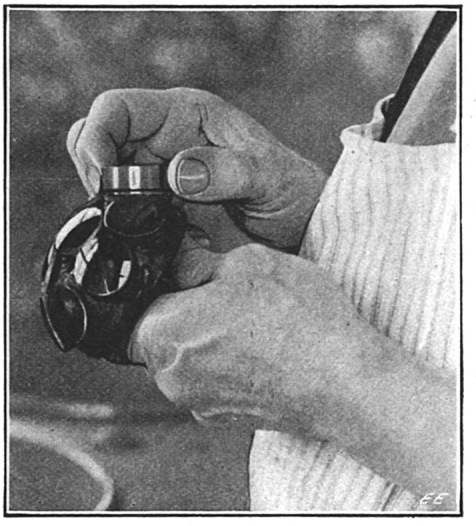
is chemical glass. It contains the same raw materials as crown glass, except that potash is substituted for soda. Flint glass is used for making optical instruments and for ornamental and cut glass. It contains silica, potash and lead oxid. The presence of lead accounts for the great weight of cut glass articles and also their high lustre.

In the making of any kind of glass the ingredients are mixed in the proper proportions in huge melting pots of clay and fused to a thin liquid During this process chemical changes take place by which silicates of soda, potash, lime or lead result. Therefore glass is defined as a mixture of metallic silicates. Silica alone, when fused, is transparent and resembles glass in the physical appearance.

To tell briefly the story of optical glass in America and the creation of this new industry will cover the main points in the manufacture of glass and the high degree of skill that must be exercised in its manipulation. As early as 1853 John J. Bausch, the pioneer in this field, opened a small shop in Rochester, New York, and began the grinding of superior lenses that soon attracted the notice of New York opticians. They were even better than those imported from Europe and Bausch found a ready market for all that he could make. But altho Bausch could grind lenses exhibiting the highest craftsmanship and perfect optical qualities, he was dependent upon Europe for his supply of glass. The demand for this kind of glass was so small and its composition so shrouded in mystery that no one here had attempted to make it.



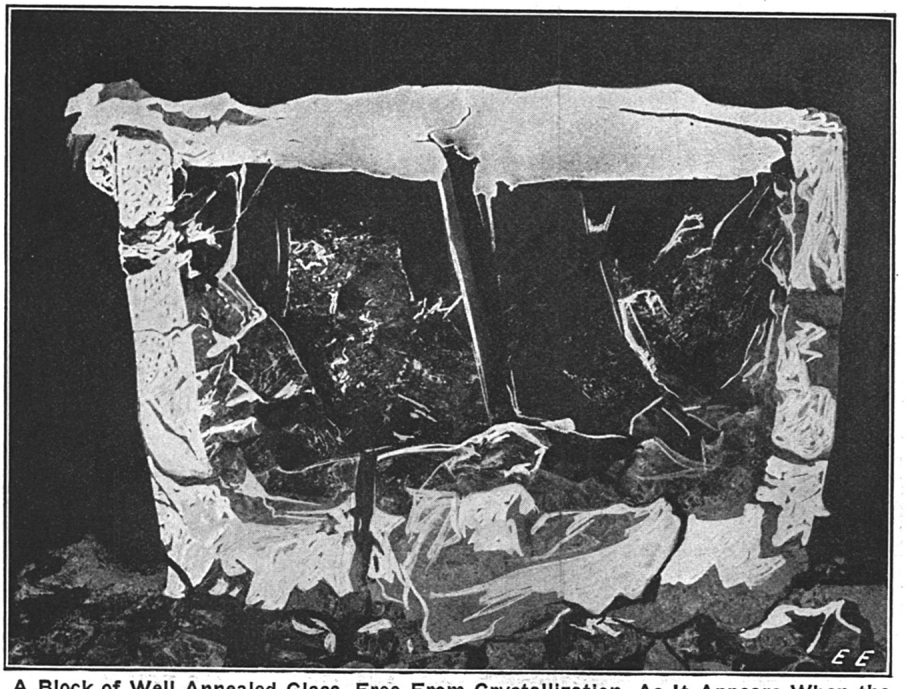
The Fine Grinding of a Camera Lens. The Lenses Are Mounted in Polishing Heads and By Means of the Handle, the "Head" is Given a Circular Motion in a Polishing Trough, With Rouge and Certain Other Fine Abrasives Used as Grinding and Cutting Agents.



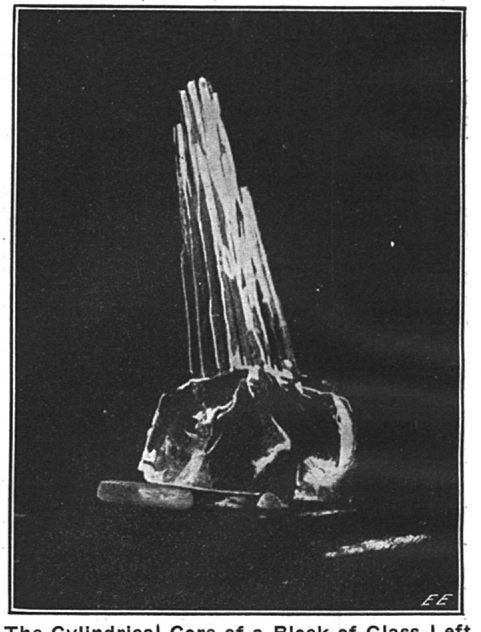
Testing the Curvature of Polished Surface of a Camera Lens. As Will Be Seen Several Lenses Are Mounted in a Polishing Head and These Are All Ground Down and Polisht Together. The Test of Curvature is Made With a Special Device.

But to Bausch this was a most disconcerting feature of his work. He wanted to be independent. Long and persistently he sought to solve the problem of making glass that would meet the high requirements of his art. His son William Bausch also became even more interested in solving this problem. But when he looked about for skilled workmen having a knowledge of the process, he could not find even one in all America. He persistently advertised in trade journals thinking that perhaps some workman from the optical glass works across the water might have drifted to our shores, but it was a vain hope. At length, however, he did succeed in finding a Belgian, whose father had made optical glass in Europe, and he was engaged for the difficult task. A very small plant with one oil-fired furnace was built on the banks of the Genesee River. With great expectation the first batch of raw materials, selected with the utmost care, were mixed in the melting pot and fused in the furnace. But to their keen disappointment the product was found to be a beautiful emerald green and utterly worthless for optical purposes.

(*Continued on Page* 342)



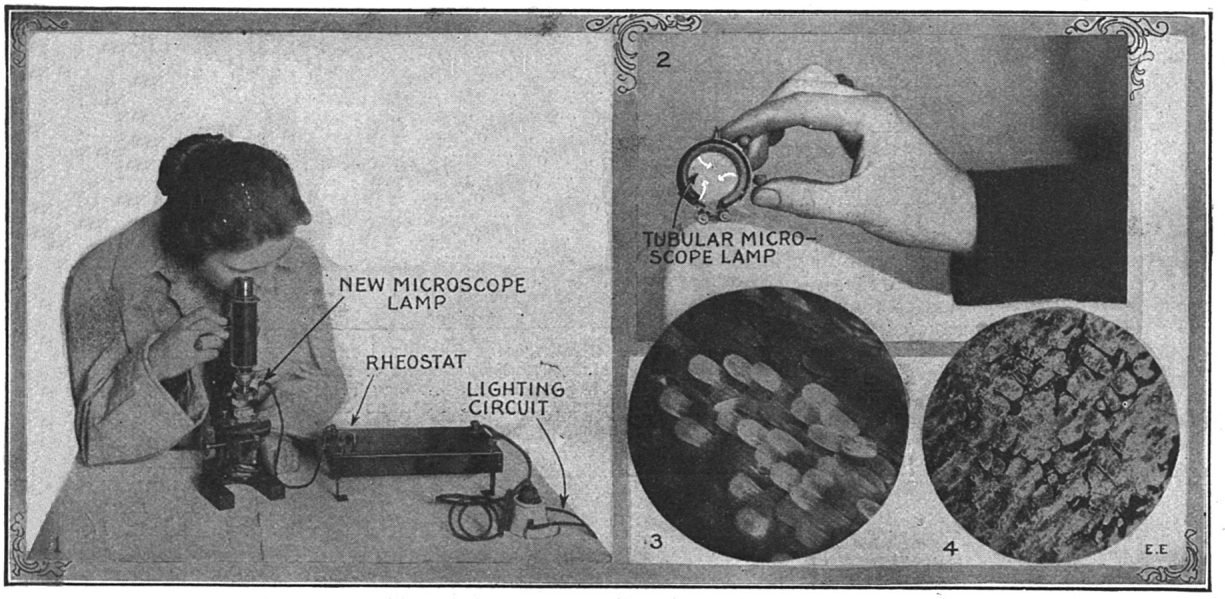
A Block of Well Annealed Glass, Free From Crystallization, As It Appears When the Melting Pot Has Been Broken Away. From Geophysical Laboratory, Washington.



The Cylindrical Core of a Block of Glass Left When the Outer Portions Broke Away. From Geophysical Laboratory, Washington.

More Light for Microscopes

By MERRILL M. HUNTING



The Illustrations Show the Latest Electric Light for Microscopes, Which Promises to Lend Itself Admirably to all Classes of Microscopic Work. The Lamp Itself Comprises a Glass Tube Containing a Long Straight Filament Running the Length of the Tube. A Rheostat Permits any Degree of Illumination To Be Obtained at Will. Figs. 3 and 4 Show Two Micro-Photographs Taken by Means of This Light, Which Indicate the Extremely Clear, Even Illumination Which Is Obtained.

THE invention of Professor Alexander Silverman of the University of Pittsburgh, which virtually consists of a new "eye for microscopes" has benefited the technique of microscopy to a wonderful degree. This new illuminator makes possible a clearer picture for the eye to see, and takes away any image, such as a lamp filament or other interference that tends to cast a cloud or haze on the picture. The invention offers new possibilities.

The extra eye, originated by this Pittsburgh professor is a new design of illuminator for the microscope which consists of a quarter-inch glass tube, containing a single tungsten filament. This tube is shaped into a circle and the lamp itself held by a holder having three iris-like fingers, which fasten securely to the objective of the microscope by a clamping action. The lamp is silvered, throwing light downward on the subject under observation. No light goes where it is not needed.

When in use, the "new eye" uses a rheostat for utilizing current from a 110 or 220 volt lighting circuit. The lamp operates at 0.9 ampere and 13 volts for visual work, by simply pushing the button switch. For photographic work it is operated by pushing a spring switch and uses 1.01 amperes and 18 volts current. This lamp is made in two glass colors, either colorless or blue (daylight) glass at nominal cost.

In the taking of photographs especially, much time is saved over the older designs of illuminators, the vertical for instance. After once attached to the examining lens no further adjustment is necessary as it is raised and lowered with the objective of the device in use. Photographs are taken in from 10 to 40 seconds. This long exposure is possible because of the fact that the illuminator is attached to the microscope and moving with it, tends to eliminate any vibration, should it occur.

With it, examinations of objects in deep hollows can be easily carried on.

Dr. Langmuir Has New Theory of Matter

An entirely new theory of the structure of matter was recently presented at the concluding session of the annual gathering of the National Academy of Sciences by Dr. Irving Langmuir of the General Electric Company research laboratory. Explaining that his conclusions led to a new conception of energy, force, time, space, magnetism and all the general properties of matter, Dr. Langmuir asserted that "space and time have a structure analogous to that of matter."

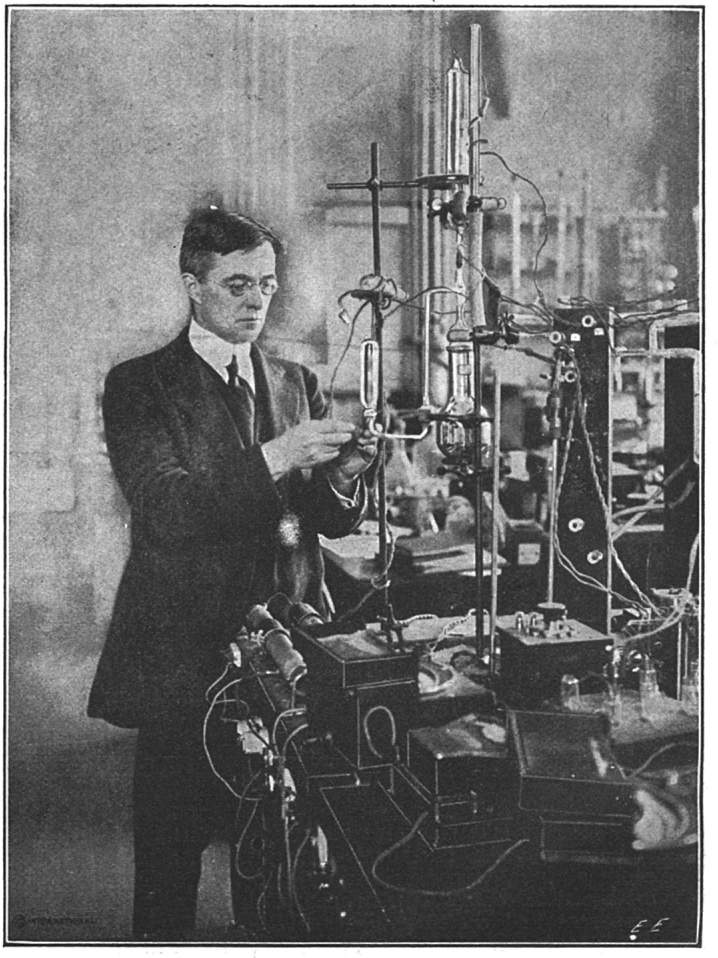
Heretofore, the speaker said, the usual conception of the relative order of the components of matter has been atoms, molecules, electrons and particles. His observations add a new division, smaller even than the electron, which he has named the "quantel."

It consists of two parts, he said, positive and negative, present everywhere in space moving in all directions with the velocity of light and capable of passing thru matter. They constitute, he added, what has heretofore been known as the "ether of space" and cause all of the phenomena of light, electricity, mass and energy.

"The structure of everything that is" can be built up out of his conception of the quantel, Dr. Langmuir said. The theory explains all of the mysterious relationships heretofore known to exist between spectral lines, he asserted, predicting that it would lead to the discovery of many new relationships.

His observations also demonstrated a new principle of reversibility, Dr. Langmuir declared, that leads to the deduction that light proceeds in straight lines from atoms, that it does not radiate but proceeds from each atom to a fixt objective.

Dr. Langmuir's theory was based, he said, on the theories of several other scientists, and that he had already gone far enough with his experiments to derive the most fundamental mathematical formula and to see by what was to him a simple process, a development that would help to explain all the phenomena relating to the properties of matter. His experiments were predicated on the Einstein special theory of relativity, Dr. Langmuir said.

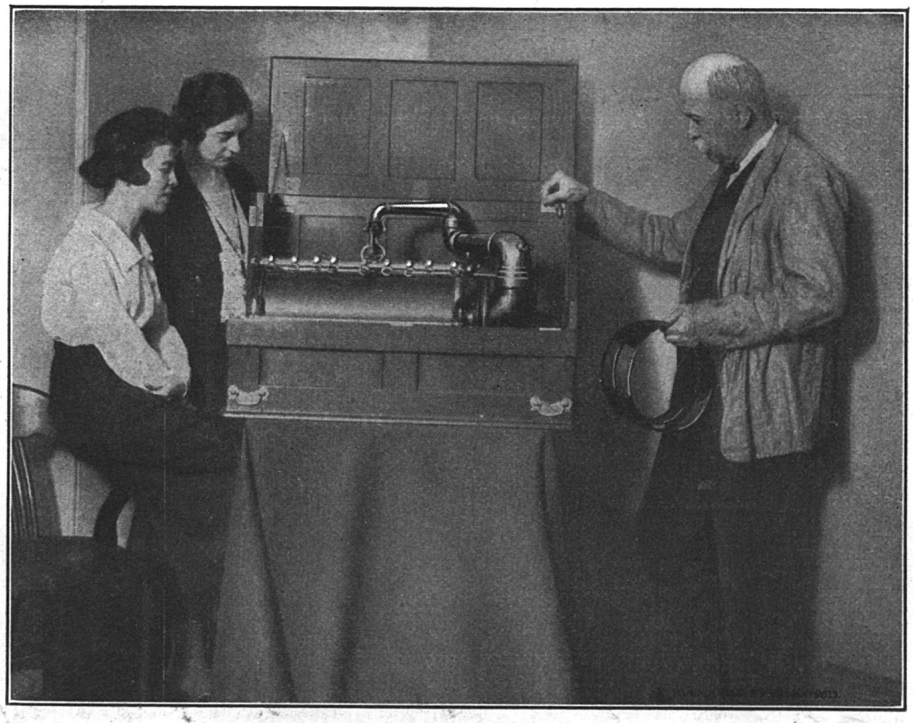


Dr. Irving Langmuir, an American Scientist, Whose Theory of a New Construction of Light, Energy, Matter and Magnetism May Rival Newton's Discovery of Gravitation. His Theory, Which He Read Before the National Academy of Sciences in Washington, D. C., Discloses the Smallest Division of Matter, Smaller Even Than the Atom, Which He Calls the "Quantel." Dr. Langmuir Is Only 39 Years Old and Was Born in Brooklyn, N.Y. He Is a Graduate of Columbia University and Received His Doctor's Degree from the University of Göttingen.

New Phonograph Talks One Hour

The photograph shows Mr. George W. Bowers, mechanical and consulting engineer, of Boston, Mass., listening to his wonderful new phonograph which will reproduce continuously or intermittently for an hour or more, and will stop automatically at any predetermined time or spot, and will render a concert of one or more hours' duration, made up of records varying from three minutes to one hour's duration. It plays from record to record automatically and is said to have a tone far superior to any machine now on the market. Six years' time and many thousands of dollars have been spent in its preparation and it is said eighty-four patent claims, many of them basic, have been allowed. While designed to play specially made records, it will also play regular records.

As shown in the photo, the records as designed by the inventor are short cylindrical affairs, but the machine can be arranged to play any record of the orthodox flat type. The records used by the inventor, one of which he is shown holding in the photo, shows how the music grooves are recorded around the outer perifery or surface of the composition ring. Such phonographs are now in demand for many different locations, such as in large private ball rooms, dance halls, community houses, soda water parlors, and in fact everywhere that it is desirable to play a series of records thru a period extending over an hour or more.

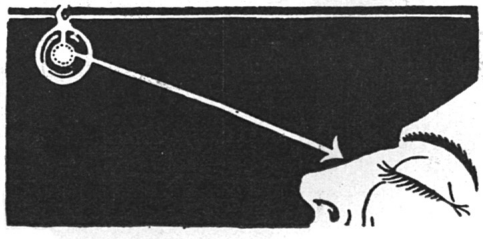


The Accompanying Photograph Shows a New Automatic Continuously Playing Phonograph Which Can Be Set Up to Play a Dozen Records One After the Other. The Machine Takes Special Records, Two of which the Inventor Is Shown Holding in His Hand, but It Can Be Adapted to Play Standard Records.

Radium Sleep Button

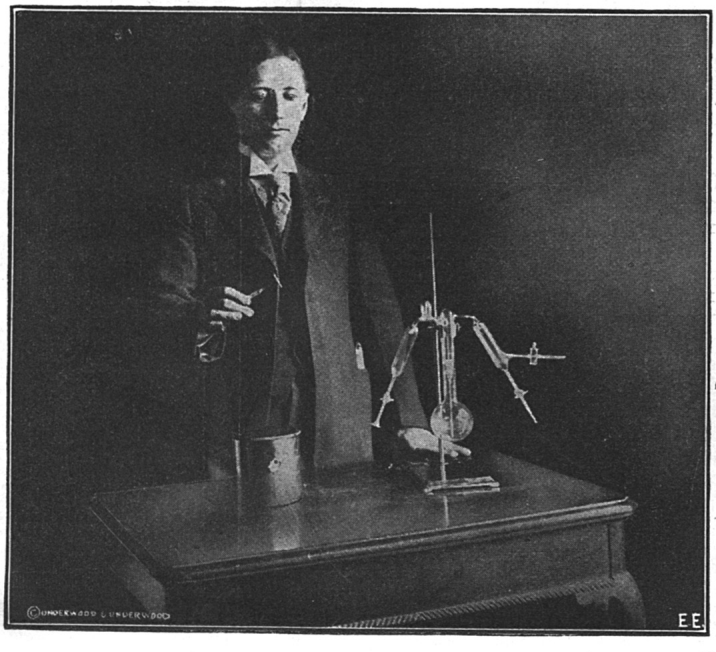
This latest "invention" comes from Germany. People are having so much trouble there now that they simply cannot fall asleep, hence we have the radium button as shown. This is actually being advertised in a high class German periodical and is supposed to work as follows:

The button, which is nothing but an ordinary "Radiolite" button such as are sold in this country, is placed in such a position that while lying in bed you gaze at it fixedly. This is supposed to auto-hypnotize you and within a few minutes you are sound asleep. Anyway it sounds very good, and is worth while trying. If you have not a Radiolite button you may try your watch if it happens to have its hands coated with radium paint.



Radium Bank Starts With $375,000 Capital

Physicians and surgeons are gradually learning more and more about the curative and therapeutic properties of radium, especially in the treatment of cancer, as time goes on. A few years ago there were a great many doubts exprest as to whether radium would ever actually cure cancer or carcinoma, but the results obtained in many different clinics at some of our leading hospitals and sanitariums show that radium will and does produce curative results in such cases which are permanent.



On the Table in the Photograph Is a Container Which Has Half of the $375,000 Worth of Radium To Be Used in the Foundation of the First "Radium Bank," Which Will Distribute to American Physicians and Scientists to Use in Therapeutic and Research Work. The Inventor and Patentee of a Secret Process Which Made It Possible to Mine This Element from American Mines is Dr. S. A. V. Sochocky (Shown in Photo, Holding in His Hand a Tube Containing Approximately $5,000 Worth of This Element in the Tiny Capsule the Size of an Ordinary Pin). The Photo Was Taken at the Annual Meeting of the New York Medical Society at the Waldorf-Astoria.

In cancer of the throat the tube is held in the throat or back of the mouth for a short period of time, once or twice a day, while the treatment is taken. Where incisions have been made to get at cancers or other growths, the tubes containing the radium bromid are laid directly in the incision so that the powerful penetrating rays shot forth from the radioactive salts can work their miracles, with the highest efficiency possible.

All of which brings to mind a most peculiar and almost tragic incident which happened several years ago to a patient who was taking radium treatment for cancer of the throat. Several tubes of radium, valued at many thousands of dollars, were anchored at the end of a thread in the throat of the patient. Owing to the unusual conditions, the patient suddenly exercised a muscular spasm and swallowed the radium tubes! Two serious things could have happened: The radium might have been lost forever; and the patient might have died sooner or later! But neither of these two things actually occurred. The radium tubes eventually past off, the doctor recovered his precious little glass tubes, and the patient still lives to tell the tale.

Overcoming Gravitation

By GEORGE S. PIGGOTT

Startling Electrical Experiments by the Author in Actually Suspending Gravitation Which Present a New Aspect of Gravitation

FOR some time past there has been quite a controversy going on regarding the subject of interplanetary communication by means of electric waves. I have been very much interested in the above on account of experiments which I have made and data collected pertaining to gravitation effects on high frequency oscillations and electronic discharges in general. A series of experiments which I conducted during the year 1904, caused me to formulate the theory that interplanetary transmission of electrical impulses was an impossibility on account of the sun's resisting and absorbing influence which virtuallly isolates our planet from all other electrical vibrations of a lesser tension or power.

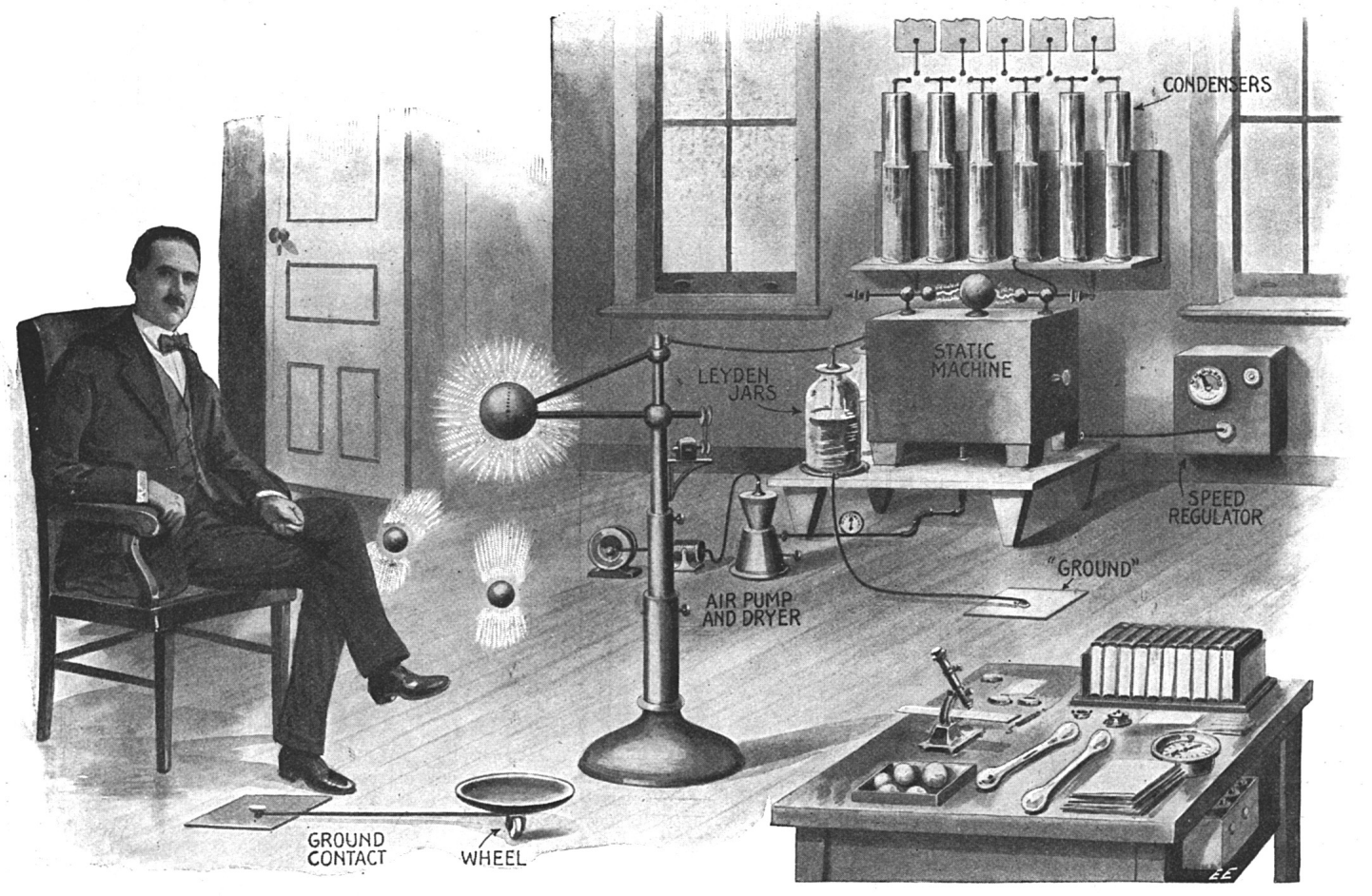


Fig. 1. This Picture Shows Mr. George S. Piggott, the Author, and His Laboratory With the Powerful Electrical Apparatus Used, Whereby He Was Enabled to Carry on Successful Experiments in Nullifying the Effects of Gravitation. In Other Words, He Was Able to Suspend Small Balls and Other Objects in the Manner Shown, the Silver Balls Actually Used Having Weighed 1.3 Grams. The Diameter of the Balls Was 11 mm.

GRAVITATION SUSPENDED IN EXPERIMENTS.

The above theorem was arrived at after I had succeeded in sustaining a metallic object in space by means of a counter-gravitational effect produced thru the action of an electric field upon the above object. A strong electric field was produced by means of a special form of generator and when the metallic object was held within its influence it drew up to approximately a distance of 1 mm. from the center of the field, then was repelled backward toward an earthed contact, going within 10 cm. of the same when it was again attracted toward the field's center but this time getting no nearer than 5 cm. from the polar nucleus. This backward and forward movement continued for some time until the metallic object at last came to a comparatively stable position, about 25 cm. from the field's center where it remained until the power was shut off. While the metallic object was suspended, I was able to study the effect of the surrounding field and found by means of a powerful microscope, assisted by the insertion of a vacuum tube within the field, that the metallic object (having of course a certain electrical capacity) became fully charged and gave off a part of said charge to and against the surrounding field which tended to hold said object in space, apparently without any other sustaining influence. Around the outside of the metallic object and extending to a distance of about ½ cm. was a completely dark belt or space in which there appeared to be no electrical agitation due, possibly, to neutralization caused by the contact of the large incoming energy supply from the field's center, with the small oscillating radiations from metallic object. The ever changing action of attraction and repulsion resulted in the overcoming of gravitation. Going farther I willl state that the dark belt above mentioned after many tests gave no sign of electrification, a most astonishing phenomenon, inasmuch as its width was but ½ cm. In fact, a dark line was shown in the vacuum tube when it was introduced between metallic object and center of field. It is my firm conviction that somewhere on the outer confines of our planet there exists a similar counteracting belt thru which naught but the gravitational vibrations of the sun penetrate, and these vibrations absolutely annihilate or absorb all other less powerful ones.

Therefore, after making many experiments to ascertain as nearly as possible the absolute facts and conditions as they exist, I have come to the conclusion that all electrical disturbances not due to our own radio oscillations on this globe are due to the sun's electrical activities in semi-inductional contact with our polar extremities.

DETAILS OF "DEFYING GRAVITY."

The illustrations 1 to 4 will possibly give a fair idea of the apparatus used, and the manner in which the experiments were carried on.

Fig. 1 shows general scheme of arrangement of devices. In the lower left hand corner is shown the "ground contact," which can be turned around and placed in any po-

sition found necessary, in fact, when metallic object is in suspension, this *ground* can be entirely eliminated.

I have found that any substance within the limits of my experiments can be held in suspension, viz: water globules, metallic objects, and insulators being among those tried. Some materials such as cork and wood exhibit peculiar activities when suspended; a piece of green maple would not rest in one position within the field, but oscillated backard and forward continuously, going to the field's center, then back to ground.

Heated materials exhibited equally peculiar characteristics: A silver ball 11 mm. in diameter when heated, remained farther away from the field's center than when at normal temperature; upon cooling it gradually drew up to the position it would occupy if unheated.

Fig. 2 shows a generator of the Wimshurst type (improved), the generating or collecting units being entirely enclosed in an insulating case and operated under a pressure of 3 atmospheres; completely dry air *only*, entering case thru drying device attached to air-pump shown in Fig. 1. Interior parts of generator will retain quite a powerful charge for a long period of time.

Fig. 3 illustrates suspension stand and field producing electrode, the latter can be revolved in any direction by means of a spring motor shown on upper section of stand.

The small apertures seen in electrode, which is hollow, are there for the purpose of ascertaining the action of the reduced field tension at these points, and are also made use of to hold different sized metallic discs, which are cemented to insulating plates, forming condensers, the function of which is to create weak opposite polarities at these points and thus show a reaction on the suspended object and also a greater ocular effect in the vacuum tube.

Fig. 4 is a detailed drawing of the vacuum tube principally used; this is of the spectrum type, without sealed-in electrodes and when introduced into the electric field, glows very brightly at its extremities, especially giving a sharp line bordering the dark space around the metallic object. A very high vacuum is sustained in the tube and it is found necessary to build it of a very perfect insulating glass; the bulb must be kept absolutely dry on its outer surface.

Different tubes have been used beside the above; corrugated, spherical, cone shaped, and cylindrical, with various results.

The electric field produced for suspension experiments is very powerful and intense, being detectable with a vacuum tube at a distance of over 6 meters (19.68 feet).

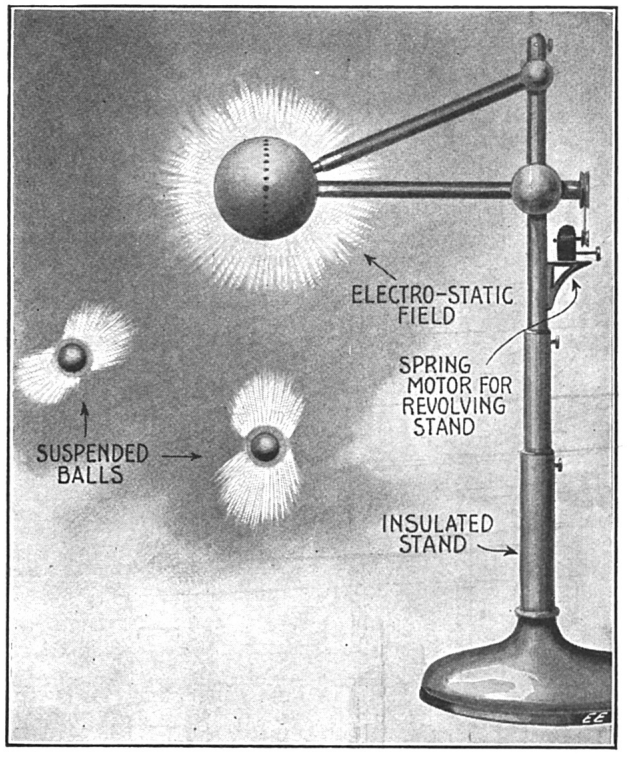


Fig. 3. A Close-up View of the Charged Metal Sphere Mounted on a Pedestal Together With a Spring Driving Motor, Whereby the Electrode or Charged Ball Could be Rotated. The Two Small Silver Balls Are Shown Suspended in Mid Air, the Earth's Gravitational Pull Having Been Nullified.

In conjunction with the above and drawing an analogy between the same, I am of the opinion that cometary motion is undoubtedly due to the activity of its compositional elements and their susceptibility to changes of polarity, which, when the comet is far distant from the sun, would be opposite in sign to that of the latter, or when in close proximity to the central orb, would be of the same sign and therefore repelled.

All bodies in process of formation possibly have their cometary stage, and doubtless future experiments will reveal this fact.

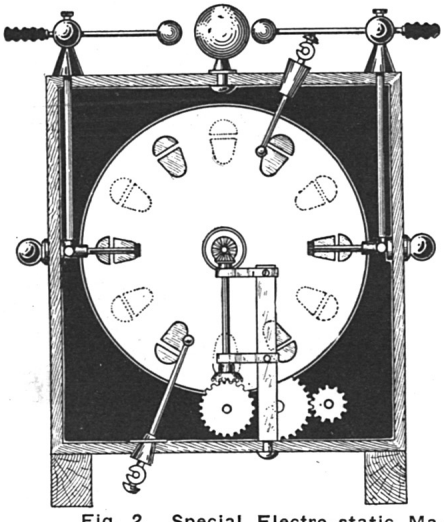


Fig. 2. Special Electro-static Machine Used by Mr. Piggott in His Gravitation Nullifying Experiments, Which Was Inclosed in a Heavy Air-tight Compartment, So That it Could be Operated Under Several Atmospheres of Air Pressure.

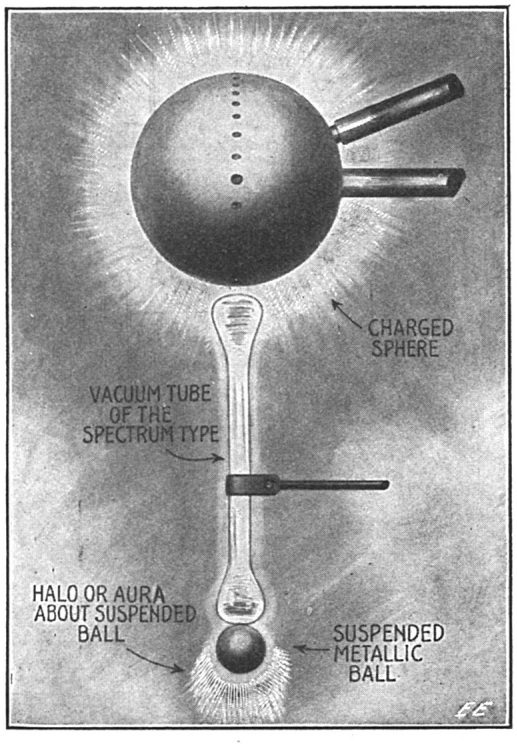


Fig. 4. Close-up View of Vacuum Tube of the Spectrum Type Used in Studying the Aura Surrounding the Suspended Silver Balls, While They Remained Suspended in Space.

ACTUAL RESULTS ACHIEVED BY MR. PIGGOTT

The total power required to operate generator, which was run by electric motor, was about ¼ K. W. generator; the machine voltage was in the neighborhood of 500,000 when the electrodes were separated beyond sparking distance. The electrostatic charge left on the suspension electrode retained the average object in space for a short length of time, about 1¼ seconds after machine ceased rotating.

Some objects such as copper and silver balls, which are of course good electrical conductors, and very nearly homogeneous, when falling toward the earth, after power had been shut off, seemed to slow down when they neared same, and hovered about 2 c.m. above contact for approximately 1 sec. of time before striking same; this was due no doubt to the inductional change of polarity which was imparted to balls almost at the instant of earth contact.

The aura, shown in figure 3, near suspended balls (which in this experiment were made of silver) extended outward to a distance of about 1 c.m. and covered about one-half of the upper hemisphere and a trifle more of the lower hemisphere.

This bluish emanation appeared to be made up of numerous infinitesimal dots or darting particles, each apparently separated from the other by *a very narrow, glowless belt*. Everything was, however, in a constant state of agitation and it was quite impossible to get an absolutely perfect view microscopically, of an individual particle. Different substances have different aura both in length and breadth, and also in luminosity.

The silver balls used in these experiments had an actual gravitational weight of 1 3/10 grams (nearly .05 oz., avoirdupois) and were the heaviest objects suspended at this time, their diameter being 11 mm. as before mentioned in another part of this article.

The largest object suspended was a cork cylinder 10 c.m. long by 4 c.m. diameter (approximately 4 by 1⅝ inches) which had a copper wire pusht thru its center, and extending beyond its ends to a distance of 3 mm. The weight of above cylinder was ¾ gram (.002645 oz. avoirdupois).

The behavior of metal spheres used in above experiments was a most interesting spectacle, silver and copper balls floated very steadily in one position and when suspending electrode was revolved, would follow and turn slightly axially, but would not revolve entirely around same, there being a peculiar "slipping" effect not entirely accounted for.

"Home Electrics"

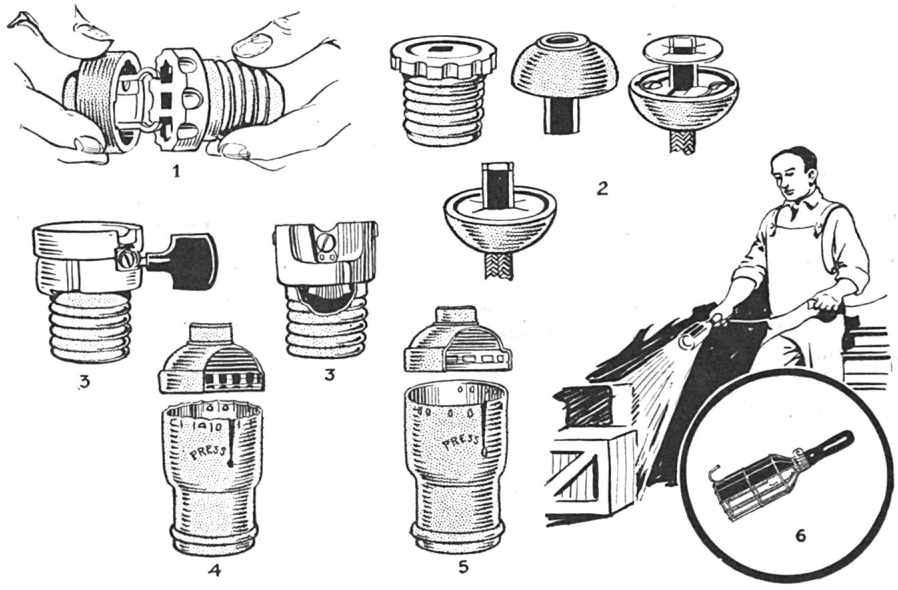
By G. L. HOADLEY, M. E.

THE EXTENSION CORD.

ONE of the handiest little articles around the electrically lighted home is an extension cord. It will naturally be one of the first things wanted.

Procure a *new re-enforced flexible* cord of the desired length—25 feet will be about right for most purposes—and a *new* plug and socket of your electrical dealer as the needed material. Then, with a screwdriver and knife as the tools, an extension cord that will give good service for a long time can be made by following the instructions given. You are doubtless wondering why *new* material is emphasized. Because the two or three pieces of old twisted wire you have laying around can't be spliced together and connected to one of several old sockets you have on hand, which were replaced some time ago. The reason is of course that they were either partly worn out or defective in some other way. Perhaps you have some nearly new twisted pair telephone wire and desire to use it. *Don't do it.* An extension cord gets the hardest kind of usage and even with the very best materials used it is very much more dangerous than the other wiring used in your home.

The extension cord is a necessity, otherwise it would *never* be allowed by the Underwriters. It is a curious fact that wires used in houses must be kept apart at least 2½ inches unless enclosed in a metal raceway, and must be at least ½ inch from the surface wired over, yet in the extension cord the outer insulation is cotton or some other material which will easily catch fire and the two wires are twisted together as closely as possible. Is it any wonder then that the Underwriters require that the very best re-enforced cord should be used? Each wire in the cord is made up of tiny strands to secure flexibility, so the cord will assume any position needed. Furthermore, the tendency to break the wires, which is caused by the bending back and forth of the cord with use, is greatly reduced by using stranded wire. How many times will a solid copper wire such as used in telephone work bend back and forth before it breaks? Certainly not often, while the stranded wire will stand considerable abuse before the outer strands break, and even then the re-enforced insulation will be difficult for these broken strands to penetrate and come together, thus finally causing trouble. The ordinary insulation of the spliced pieces of twisted cord allow the broken strands to easily get together, however, and the pulling, tramping on, and other abuse an extension cord receives will quickly break this cord where it would not injure the re-enforced cord.



1—One Form of Approved Separable Attachment Plug. 2—Another Form of Separable Plug. 3—"Insides" of Key and Keyless Lamp Socket. 4—Well-Known Type of Socket Shelf and, 5—Another Form. 6—Illustrating Useful Reflector and Lamp Guard for Use With Extension Cord.

WITH this issue we are starting a new department entitled "Home Electrics." We could tell you a whole lot about this department, but we believe that the words "Home Electrics" are sufficiently explanatory. The average householder, and the average man or woman owning a house or living in apartments as a rule are not electricians. Very often some sort of electric work is needed, usually too trivial to call in an electrician. It is for such people that this new department has been started, and we hope our readers will like it.

—Editor.

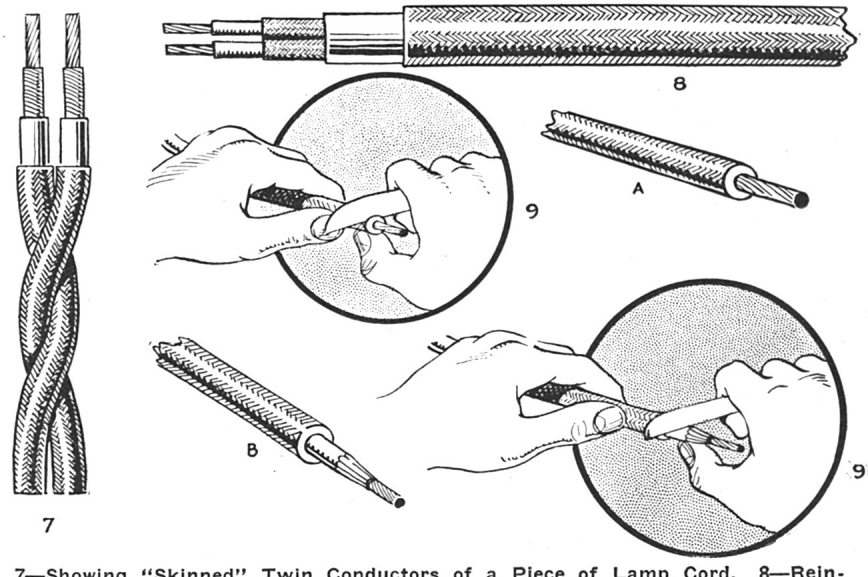
If an old worn or partly defective socket or plug is used, the temper of the user is apt to be sorely tried, to say the least, as just when a light is needed in a hurry the thing won't work and considerable time has to be spent examining it and having a screw tightened here or something else adjusted before it will work. Frequently, too, severe shocks are received from defective sockets and plugs and the blowing of fuses results from their use. Other good reasons could be advanced to show the necessity of using new material for the extension cord. Enough have been stated, however, to show why scraps won't do.

Both the socket and the plug should be of material that is not easily broken. For example, porcelain sockets will break the first time they drop on the floor. A socket made of brass and a plug of moulded composition material or one of hard rubber will give satisfactory service. The plug should have a separate cap and preferably to be of the type known as the "Separable Attachment" which will break or pull out at any angle as indicated in Fig. 1, so that an accidental jerk on the cord can do no damage to the fixture, wires or appliance. Children and even adults are apt to trip up or run against an extension cord when in an unusual place temporarily, and this separable attachment plug is of more importance than it really appears at first glance.

In selecting the plug and other parts of the extension cord, get materials which have the approval of the Underwriters. You are certain then that the device is safe after being completed. A plug, for instance, having a cap like that shown in Fig. 2, never will have the wires pull loose from the cap itself—a common source of trouble in cheap wiring—because of the "strain relief" wiring shown. In the illustration, Fig. 2, the two wires are carried around thru easily wired channels forming a perfect "strain relief." This does away with the necessity of a knot in the cord also.

The socket may be either of the keyless type or it may have a key interior as shown in Fig. 3, and the socket shell may be any one of the approved fittings of the Underwrites. Figs. 4 and 5 show two very good

(*Continued on page* 308)



7—Showing "Skinned" Twin Conductors of a Piece of Lamp Cord. 8—Reinforced Lamp Cord With Ends of Two Conductors "Skinned", Ready to Connect to Socket or Ceiling Rosette. 9—Right and Wrong way to "Skin" Copper Wire, Either Solid or Stranded. Cut in on an Angle—Not Directly in at Right Angles, As the Wire Will Invariably Be Nicked or Many of the Strands Cut Off.

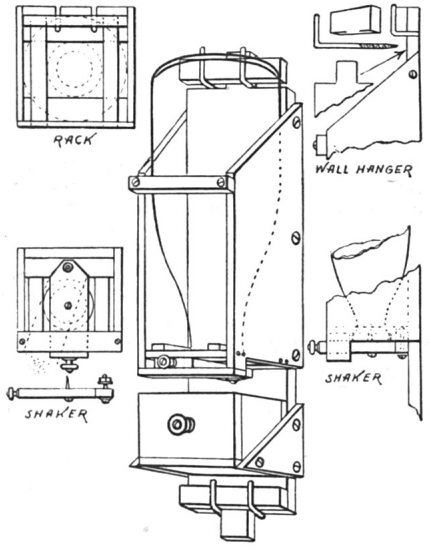
Home Mechanics

Conducted by WILLIAM M. BUTTERFIELD

THE editors believe that there are a great number of readers of the "Electrical Experimenter"—(Science and Invention) who will enjoy a monthly page devoted to "Mechanical Rinktums." Something Useful one can build on that odd half-day off and withal a device that can be built from wood or metal stock usually to be found about the home work-shop. We have arranged with Mr. Butterfield to conduct this monthly feature—and we want it to be "your" department. Letters containing suggestions on what you want to see described here will be forwarded to Mr. Butterfield.

MOISTURE PROOF CANISTER.

A shaker for holding salt, sugar, ground coffee or similar dry materials, and thus protecting them from moisture, is shown in the sketch herewith. It is constructed of half-inch wood made as illustrated, with a suitable glass bottle, say an ordinary quart milk bottle, as the container—the wooden parts forming a convenient wall bracket holder, a shaker for pulverizing and releasing the material in the container; and a box for receiving said material.



An Easily Made Moisture-Proof Canister for Holding Salt, Sugar, Etc. It Is Provided with a Shaker for Damp Days.

The back piece is 16¼ inches long by 3⅞ inches wide. This forms the foundation for the device; at their end a tongue is made for attaching the shaker to frame of a door or window. Each tongue is 1 inch long by 1½ inches wide, made by sawing away the corners as shown. The sides of the bottle holder are 4⅜ inches wide and 10¼ inches long; at the front, lower edge of each, a tongue is made to form a guide for the shaker block. These tongues are ⅝ inch long and 1¼ inches wide, with a block screwed to their lower edge as shown. A rack for holding the neck of the bottle is provided, the front and back parts of which make the top edge of the shaker-block guide and form the support for the rear end of same, supported as shown with a ⅜-inch screw-bolt. The top ends of the sides are sawed at an angle, with a retaining block for holding bottle placed in the position illustrated in the drawings.

The shaker block is ½ inch thick, 4⅝ inches long and just wide enough to completely close the opening of the bottle when centrally placed, say 2¼ inches for a milk bottle. The bottle rides on the block and as the latter is moved from side to side, as shown in the dotted lines on a small drawing, an opening first at one side and then the other in the throat of the bottle is formed. To pulverize the material should it become caked after being placed in the bottle, one or more nickel plated iron screws are screwed thru the block so as to extend an inch or more up into this glass container as shown. A box, with a suitable shelf support, is provided to catch the material thus released.

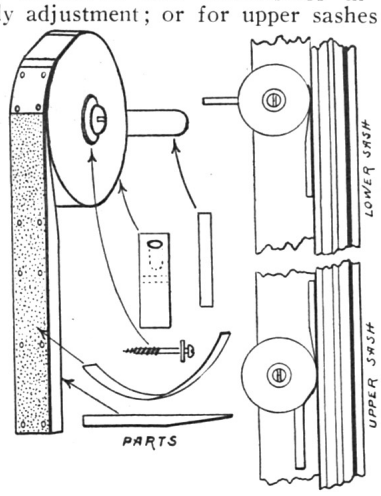
The container may be placed in its frame by using the cardboard cap that covers the milk; this is afterward removed when in place, or by placing the frame inverted over the container as it sets right side up on a table, it is an easy and quick adjustment in either case, once you get the hang of it. This shaker is particularly suited to those living along the seashore or in damp locations.

AUTOMATIC HOMEMADE WINDOW LOCK.

A window lock that operates automatically, is simple and inexpensive, and can be made at home in numbers sufficient for the largest house, is seen in the illustration. Each lock consists of a 2 inch thick wood wheel suspended on a ⅜ inch screw in such a way that its rounded surface is brought against the inside face, or one side of a window sash at the top rail, thus allowing the lock to operate along the full length of the sash as it is moved up and down in the process of operating this part. Suspended from and nailed to this rounded surface, is the doubled end of a strip of emery cloth, of the roughest grade as we have shown; this strip also carries nailed to it a ½ inch thick wood wedge of the same width as the thickness of the wheel. On the opposite side of this disc a ½ inch iron bar is driven into a hole in its edge to act as a weight to hold the disc by force of gravity in a way to cause the wedge to remain at the first entering position between the wheels and the face of the window.

The rough emery cloth takes hold of the wood with increasing force as the wedge is forced home by the movement of the sash, causing it to bind with such tension in its frame as to lock the window. It will, however, become operative when the bar is released, so the sash can be said to be continually locked.

Such a lock as is here shown will be useful for sashes, provided with the regulation fasteners, but which are liable to be left unsecured thru carelessness in their daily adjustment; or for upper sashes that can be reached from other buildings as is often the case in New York or other crowded locations. We show the reverse mechanism for an upper sash lock in one of the drawings.

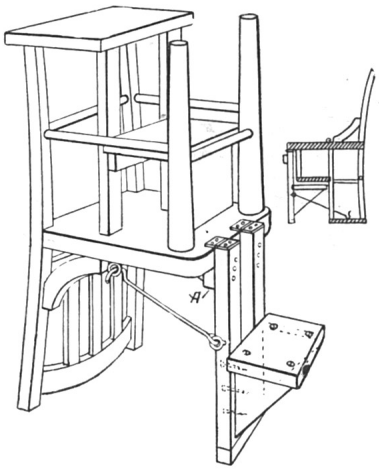


Self-Wedging Window Locks Made From a Wooden Wedge, a Drum, and a Piece of Emery Cloth.

The important features are, to have the screw hole in the center of the wheel; to have the wheel move freely on the screw when in place, so that the upper weight or wedge can function properly; and to have the rough face of the wedge take quick and firm hold of the wood sash.

CHAIR STEPLADDER.

Here we have a method of converting an old wood bottom chair into a "safe" four-stept ladder. This can be accomplisht with little or no expense and thus give the "overall" or Economy Movement another boost. The required materials for accomplishing this transformation are three feet of ¼ inch wire, four screw eyes large enough to take in the wire, two 1 by 2 inch hinges of the style shown, and some ¾ inch lumber.



Here's a Clever Idea—a Step-Ladder Made From an Old Kitchen Chair. Anyone Handy With Hammer, Saw and Screw-driver Can Readily Build This "Chair" Step-Ladder. It's Stronger Than You Imagine and Very Stable—a Trait Seldom Found in Many Expensive Ladders of This Type.

It will be impossible to give definite widths, lengths and so on, as the chairs all differ in size, but a fine suggestion may be given to aid the prospective builder. It will be advisable to make and attach the lower step first, even to fixing the wire and screw eye side-straps; when this is done the building of the upper part is more easily accomplisht. One important suggestion is to have the block "A" very securely fastened, using three screws or nails in each end as shown; this block holds the front of the chair. The step with its end brackets must also be put on securely, using screws in preference to nails in the manner illustrated; another important precaution should be mentioned, that of making it impossible for the straps to become unfastened when hooked in place; these straps are vital in preventing stepladder accidents.

The top step is put on after sawing off ¾ inch from each back leg of the chair, or screwed to the legs and supported in front by two uprights that are fastened to both the step and the chair bottom. These also form the support for the third step, carrying the cleat on which the back edge rests. A front support made of a board is provided for this step; the second step is formed by the chair bottom.

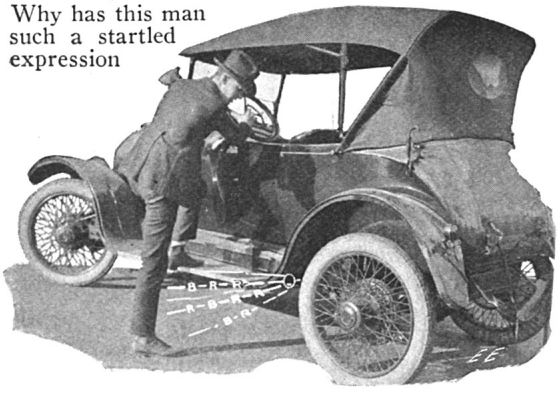
The chair ladder, if the steps are spaced correctly, will now fold up in the manner shown in the small drawing, the top steps remaining permanently as shown by shaded lines.

AUTOMOBILE "STUNTS"

FIRST PRIZE $25.00.

ELECTRIC "THIEF ALARM" FOR AUTO.

Why has this man such a startled expression



Step on This Running Board and the Klaxon Wails Out Its Warning.

on his face as he steps into the car not his own? The reason is a wildly screaming automobile horn partly concealed under the running board where it joins the rear fender. The owner purposely put it there. When the running board is stept on, a circuit is completed and the horn yells its warning.

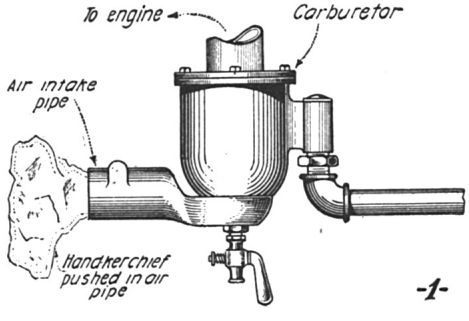
Contributed by EDNA PURDY.

SECOND PRIZE $15.00.

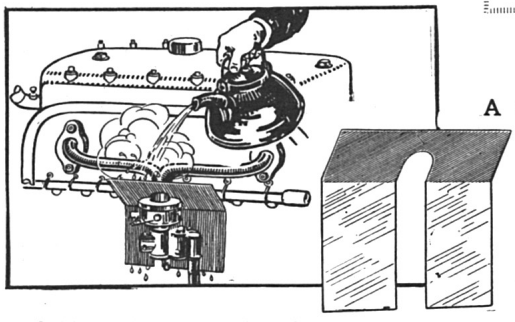
STARTING THE ENGINE IN COLD OR DAMP WEATHER.

The accompanying illustration shows two stunts which I have found very useful in starting the engine, even in very cold weather. They have also proven very efficacious and valuable in the spring and summer, especially on damp, cool evenings when the engine has thoroly cooled and is stubborn when trying to start it.

The first one I invented after ascertaining that a rich mixture is the best for starting and as the air regulator did not close down tight, I hit upon the idea of pushing a handkerchief or other piece of cloth (but NOT waste) into the opening of the air intake pipe on the carburetor.



To Cut Off All Air in Starting up Stuff a Handkerchief or Rag in the Air Intake Pipe.



In Cold or Damp Weather Starting Is Made Easy by Pouring Hot Water on the Intake Manifold.

In this case, the air intake pipe was open, but in some cases this may be closed so as to be well nigh inaccessible owing to its attachment thru a "stove," attached to the exhaust pipe, for the purpose of heating the air fed to the carburetor, as many cars do.

The second illustration shows a stunt which has proven efficient on the coldest mornings, when the engine refused to turn over even after a thoro priming. Simply use hot water right out of the tea kettle, the hotter the better. A piece of tin or asbestos sheet should be bent around the carburetor, so that the hot water does not run all over and possibly into it thru some opening, and thereby cause no end of trouble. The heat from the hot water rapidly warms the intake manifold pipe leading from the carburetor to the engine cylinders, and permits the gaseous mixture supplied by the carburetor mechanism to easily and more readily vaporize.

Contributed by EVERETT ACKERSON.

$50.00 In Prizes

Beginning with this issue, we start on this page a new automobile department entitled "Automobile Stunts", and we will pay $50.00 in prizes for the three best articles received each month.

A great many of our readers have a car of their own, and any number of them have made certain improvements on that car. We want to know about these improvements. Almost every other automobilist some time or other invents a little device or does something to his car to make it better than it was before. "Experimenter" readers want to duplicate these stunts, and that is just what this new department will be for. In other words an exchange of ideas. Note that the idea does not necessarily have to be electrical in any way. You may have a new stunt or trick how to patch a blown tire that was not described before. You may have a new idea how to prevent your spark plugs from carbonizing, and thus short circuiting. You may know of a new stunt how to refill or charge a storage battery. If you have a town car, you may have thought of some simple trick how to signal to your chauffeur, so he will know where you will want to go.

There are hundreds of such ideas, and we will pay $50.00 a month to get them. Of course, we would like to have a photograph of the stunt showing that it was actually tried, but this is not absolutely necessary to win a prize. If no photograph can be furnished—altho we would like to have it—a simple sketch will do showing the essential parts, etc.

We will pay the following prizes:

FIRST PRIZE	$25.00
SECOND PRIZE	15.00
THIRD PRIZE	10.00

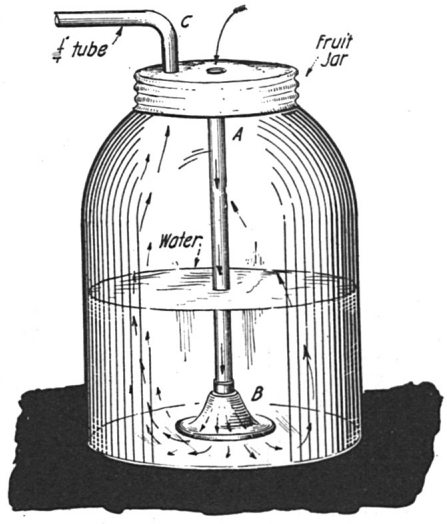
All other accepted articles, which win no prizes will be paid for at the rate of $2.00. Articles submitted should not be long ones. About one hundred to two hundred words will suffice. Address all manuscripts to "Editor, Automobile Stunts," care of this publication.

THIRD PRIZE $10.00.

A COMBINED ECONOMIZER AND CARBON ELIMINATOR.

This is a very simple device, which has been thoroly tried out by the author, with great success. The method employed is that of passing air thru water and thence into the engine cylinders.

The air is very moist and therefore has a tendency to produce steam when heated. The steam thus formed keeps the cylinders free from carbon and gives greater power on less fuel, hence greater efficiency, which we are all striving for. Actual tests show an increase of five miles per gallon of gasoline, and a loss of 50 per cent of the carbon, with an appreciable increase in power!



A Gain of 5 Miles per Gallon of Gas Is Claimed for This Simple Economizer and Carbon Eliminator.

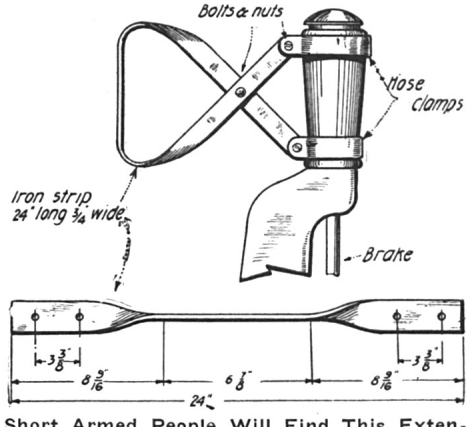
The container is an ordinary quart fruit jar with a brass top. A is a ¼-in. brass tube past thru the cover and soldered. B is a common bath sprayer soldered on the tube A. A ¼-in. copper tube is extended from C thru the dashboard to a valve which can be operated from the driver's seat. From here it goes to the intake manifold. The valve is for the purpose of turning it off when "starting" in cold weather.

It will be well worth any automobilist's time to construct this simple device, since by utilizing this, his car and pocketbook will be greatly benefited.

Contributed by A. BRILHART.

EXTENSION HANDLE FOR EMERGENCY BRAKE.

The device illustrated is an extension handle for the emergency brake. This handle is an aid to short people, who experience difficulty in reaching the emergency brake, also to help them keep their eyes on the road when pulling upon the brake in a traffic jam, or in any other situation equally as dangerous.



Short Armed People Will Find This Extension Brake Handle Invaluable.

This device can be used on practically every make of car on the market, and will undoubtedly prevent many heretofore unavoidable accidents, and is also of great help to women who have been restrained from driving cars owing to this handicap.

Contributed by FRED SMITH, JR.

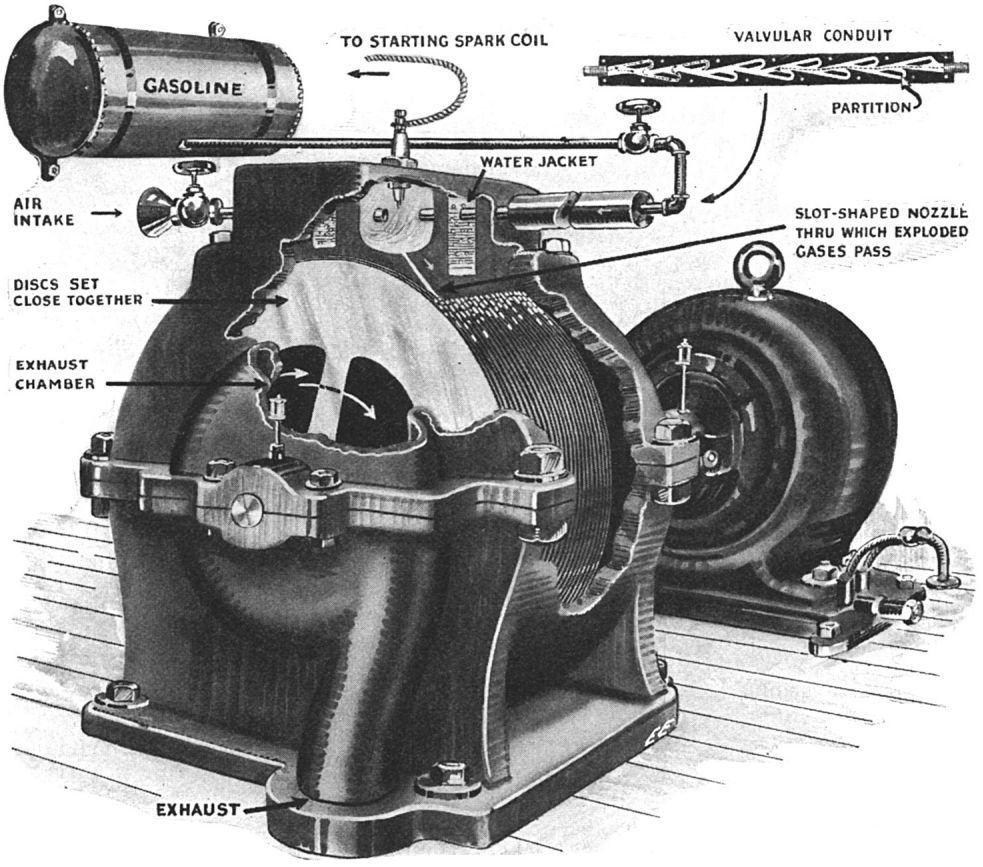
The Tesla Gasoline Turbine

By JOSEPH H. KRAUS

A Revolutionary Gas Engine That Requires No Spark Plug, No Carburetor, No Valves and No Pistons.

AN immense amount of work has been done during the past fifteen or twenty years by engineers who have endeavored to produce a simple and practical *explosive gas turbine,* but the mechanical and thermal hindrances have been so great that up to the present time no signal success has been achieved. The turbine is an ideal prime mover; simple in principle, but the accessory apparatus for operating it explosively is very complex and liable to great wear. Thus the products of an explosion must affect the rotor, during which time a number of operations have to be performed.

Fuel and air must first be admitted thru separate channels into a combustion chamber; the mixture is then ignited, all inlets and outlets closed. The comprest gases thus exploded must be directed thru a nozzle to the rotor plates or buckets and the chamber cleaned and made ready for the admission of a fresh mixture.



The Very Latest Invention in the Gasoline Engine Field Is the New Tesla "Valveless and Bucketless Gasoline Turbine," Here Illustrated. Two of the Main Features of This Remarkable Invention Are That the Usual Carburetor or Vaporizer Is Done Away With and, Secondly, No Buckets Are Necessary on the Turbine Blades, the Latter Simply Comprising a Series of Flat Steel Discs, Placed a Short Distance Apart. The Successive Explosions of the Gaseous Vapor Are Projected Thru a Nozzle on to the Blades, Thus Causing the Rotation of the Blade Members and the Shaft to Which They Are Connected. A Dynamo Is Shown Connected to the Turbine at the Right of the Picture Herewith. This Article Was Prepared in Collaboration with Dr. Tesla.

All these operations are controlled by *valves* which must be opened and closed at precise moments and therefore are generally controlled by the motion of the turbine rotor itself. Irrespective of the difficulty of keeping the valves in good order at high temperatures, at which they must operate the apparatus taken as a whole, is so complicated that the ordinary form or reciprocating type gasoline engine is more preferable.

Doctor Nikola Tesla, whom the readers of this publication know very well and whose amazing work in the various scientific fields is also universally recognized, again comes into the limelight with a very remarkable explosive gasoline turbine perfected by him recently which he describes in detail in a patent just granted. This remarkable turbine does away with all the troubles and complexity of the former attempted types. Stated briefly, the invention consists in the production of a peculiar shape *conduit,* thru which the gases are admitted into the turbine, and which has the singular property of permitting their passage in that direction only; in other words, uni-directionally.

This device when used in connection with his *bucketless* turbine produces an engine which may be explosively operated by gasoline, alcohol or other fuels and is absolutely *devoid of all valves.* It is the simplest internal combustion motor conceivable. Owing to the tremendous output of the Tesla turbine, one single disc being practically equivalent in performance to a whole bucket-wheel, a very small machine of this kind is capable of developing an astonishing amount of power. The principle of the operation will be clearly understood by the aid of the accompanying diagram.

Referring to the detailed view of the conduit, we first note a casing of metal or other suitable material which may be milled or prest from sheet metal into the desired form. From its side walls extend alternately projections terminating in buckets which in order to facilitate manufacture are congruent and spaced at equal distances.

In addition to these there are independent partitions, the purpose of which will presently be made clear. There is a nipple at each end provided for pipe connections. The bottom is solid and the upper or open side is closed by a close-fitting plate. When desired any number of such pieces may be joined in series, thus making up a valvular conduit of such length as the circumstances may require.

In elucidation of the mode of operation let it be assumed that the medium under pressure be admitted at the right. Evidently its approximate path will be as indicated by the dotted line, which is nearly straight, that is to say, if the channel be of adequate cross-section the fluid will encounter a very small resistance and pass thru, freely and undisturbed, at least to a degree. Not so if the entrance be at the opposite end.

In this case, the flow will be smooth and continuous, but intermittent, the fluid being quickly deflected and reversed in direction, set in whirling motion, brought to rest and again accelerated, these processes following one another in rapid succession. The partitions serve to direct the stream upon the buckets and to intensify the actions, causing violent surges and eddies which interfere very materially with the flow thru the conduit.

Examining more closely the mode of operation, it will be seen that in passing from one bucket to the next in the direction of disturbed flow the fluid undergoes two complete reversals or deflections upon itself thru 180 degrees, while it suffers only two small deviations of about 10 to 20 degrees when moving in the opposite sense. In each case the loss of head will be proportionate to a hydraulic coefficient dependent on the angle of deflection, from which it follows that, for the same velocity, the ratio of the two resistances will be as that of two coefficients. The theoretical value of this ratio may be 200 or more, but must be taken as appreciably less altho the surface friction too is greater in the direction of disturbed flow. In order to keep it as large as possible, sharp bends should be avoided.

The illustration shows in perspective cross-section a turbine which may be of any type but is in this instance one invented and described by Dr. Tesla, and familiar to engineers. Suffice it to state that the rotor of the same is composed of flat plates which are set in motion thru the same and viscous action of the working fluid, entering the system tangentially at the periphery or outer circumference, and leaving it at the center.

Such a machine is a thermodynamic transformer of an activity surpassing by far that of any other prime mover, it having been demonstrated in practise that each single disk of the rotor is capable of performing as much work as a whole bucket-wheel of the ordinary type. Besides, a number of other advantages, equally important, make it especially adapted for

(*Continued on page* 316)

Is Life Electrical?

By ROGERS D. RUSK, M. A.

LOOK at the accompanying diagram, Fig. 1, of a living cell in the process of dividing into two cells. What is the force causing the cell to live, grow, divide and grow some more? One theory is that it is electrical. Life, electricity and gravitation are the three most mysterious forces in nature, and life is the most mysterious of the three. Electricity can be isolated and studied; gravitation follows rigorous laws which are partially known, but the secret of life has defied the efforts of science.

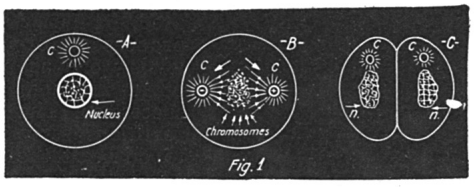


Fig. 1. "A." The Force Which Causes a Living Cell to Reproduce by Dividing in Two is First Manifested in the Part C Called the Centrosome. "B." By Some Mysterious Attraction, Which is Possibly Electrical Minute Bodies in the Fibres of the Nucleus (Called Chromosomes) Are Split in Two and Pulled to the Two Parts of the Centrosome. "C." Then the Outside Cell Wall Divides and the Two Cells are Formed.

The human body is made up of countless millions of these living cells. The simplest one of them can do all and more than man can do in his finest scientific laboratories. Every cell builds easily the most complex chemical compounds which it needs to support life, and what some of the lower animals can do is astonishing. The gymnotus, or electric eel, has been known to generate in its body enough electricity to give a severe shock, and at times enough to kill a horse. The firefly generates a kind of light without heat which man cannot imitate. The deep sea angler is one of the curiosities of science as it carries its own electric light on a long proboscis so it can see to eat in the dark. The angler is shown in Fig. II, and the light is generally carried so as to illuminate its protruding jaws.

In order to discover what life is the first problem is to discover where it is. This is a discouraging task. The biologist examines a living cell in the highest powered microscope but fails to discover the secret. The chemist then studies the compounds of which the cell is composed and decides the search must be carried still deeper. The physicist begins where the chemist leaves off and searches among the atoms and the minute electrical particles of which they are composed only to find the answer has slipt thru his fingers.

Life could not exist without the chemical changes which take place in the cell, but what is it that causes these chemical changes? The startling developments of electrical science have shown us that all forms of matter, both living and non-living, are composed of minute electrical particles called electrons, and it is these which are the probable causes of all chemical action. One of the most important chemical processes in the body is catalysis. This is the wonderful property of a minute amount of various substances to cause chemical change without being used up themselves. Examples of this are plentiful. The enzymes of the body cause the digestion of food in this way. Ptyalin in the saliva changes starch to sugar similarly. A small amount of invertase may transform two hundred thousand times its own weight of sugar. Various glands in the body secrete fluids such as adrenalin, which have a similar action and which are the accelerators of the body. It is on this basis that Dr. Serge Voronoff recently suggested taking glands from apes and supplying new accelerators to the body when the old ones are worn out, thereby renewing youth. This process of catalysis is a familiar one to the chemist, and if chemical change is due to the electrical nature of atoms, then catalysis which accelerates these changes must also be electrical in nature.

Growth and reproduction are the essentials of life, and evidently in reproduction the living force is passed on by the parent to the offspring. How this is done in a single cell is shown in Fig. I. The three most important divisions of the cell are the body of the cell, the nucleus, and the centrosome. When one cell gives birth to another by dividing in two, the dividing process is first noticed in this part of the cell called the centrosome, which is shown in the figure. This centrosome divides in two and the parts slide around to opposite sides of the nucleus where by some strange attraction they pull the nucleus into two parts, and the whole cell divides, forming two small cells which in turn grow and divide the same way. This is about all we know about life except that all inherited qualities are carried from one cell to the next by small particles called chromosomes which are found in the fibrous network of the nucleus as shown.

The electrical theory of this process of reproduction is that the two parts of the centrosome, which are the first to divide, take on opposite electrical charges and thereby attract the chromosomes from the nucleus by electrical attraction. This is an interesting theory and whether it is the true explanation or not remains to be proved. Scientists have been able to do wonderful things but they have not been able to produce life from non-living matter which does not contain the germ of life. This has been often tried. By chemical means all the compounds of which the cell is composed have been analyzed, then by still more exacting and laborious work all of these compounds have been reproduced by artificial means in the laboratory. A chemical cell can actually be made which is like the original cell in every way except that it will not assimilate food. The chemical compounds are there but the mysterious spark of life is absent.

Not long ago Prof. Loeb announced that he had succeeded in making a non-fertile frog's egg hatch and the frog grow by chemical means. This was done by catalysis, the chemicals stimulating the egg to growth. But it was a real egg, and contained the spark of life to begin with even if it had not been fertilized. The frog was short lived and evidently the chemical stimulus was only momentary instead of continuous as life is. The same experiment has been tried on artificial eggs made in the laboratory, but no evidence of life is found.

Molecules of living matter are for the most members of a class to which the name organic is given because it was one time thought they did not exist except in living bodies. This is now known to be untrue as the chemist has shown, but one outstanding fact is that these seemingly complex molecules are really made up of combinations of a few very common elements, the four most important of which are carbon, oxygen, hydrogen and nitrogen. There is nothing mysterious about these elements by themselves more than there is about any other elements. In fact in living organism they often do not seem to have as much energy as they do in some other form. For example, nitrogen as a constituent of high explosives is imbued with tremendous energy and is a giant in strength, while in living organism it is meek and mild in character, its tremendous energy lying dormant or being diverted in some manner.

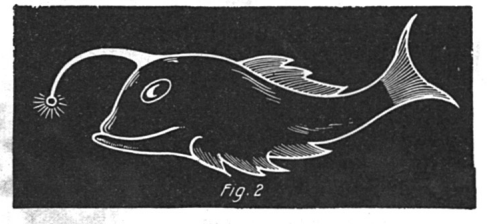


Fig. 2. A Fish that Carries Its Own Electric Light. The "Deep Sea Angler." The Source of the Energy Supplying the Light Is Thought to Be Basically Electrical; or of Nervous Origin, Which is Considered Now-a-Days as Closely Akin to Electricity in Nature, if not Wholly So.

The most striking property of matter that has yet been discovered is radioactivity. Even some of the commoner elements have been found to be radioactive, and it is doubtful whether there are more than a few elements, if any, to which this property does not belong, at least to some minute degree. If this is true it may be that radioactivity is one of the forces at work in the living cell and such a discovery would open up a new realm of study and investigation.

Life is so familiar and fundamental a process that it is almost impossible to define. There are no words more fundamental in which to explain it. It has been said that life is the capacity for self-movement; that it is the force which resists death; that it is the property of growing things; that it is a reaction continually adjusting the body to its environment, and so on. These all express a part of the true meaning of life, but the strange thing is that the most of these would also apply to non-living matter. The atoms of a gas have the capacity for self-movement, for they are constantly moving and their energy seemingly never dies. Crystals grow into definite forms, and a stretched spring reacts and pulls back against a force, moreover in time it tires just as a muscle does.

Not only biology, but chemistry, physics and all the other sciences have contributed their share in the effort to solve the problem of life. A single living cell may be composed of billions of atoms, each atom made up of electrons. Study the cell by itself, or the atom, or the electron, and the mystery of life eludes us. It is not in a single electron or a single atom. Neither is it in any mathematical formula or physical law. The ultimate causes back of the phenomena of life are too fundamental to be expressed in this way, and perhaps too fundamental to ever be grasped in their entirety by the finite mind of man. Certain it is that the trend of science as a whole is toward the view that the electron and electricity are basic factors in all processes, either organic or inorganic.

PUBLISHER'S ANNOUNCEMENT

THE ELECTRICAL EXPERIMENTER was founded in May, 1913, seven years ago, to supply an insistent demand for a class of literature that was not represented adequately in America at the time.

The experimenter, electrical and otherwise,—that vast horde of intellectual Americans, in whom the physical progress of the country is centred—had but scant literature to choose from, back in 1913. The ELECTRICAL EXPERIMENTER filled that want and filled it completely. Its success was instantaneous, which is best shown by the fact that it doubled and tripled its circulation year after year, till at this moment it has reached a total of close to 200,000 copies a month.

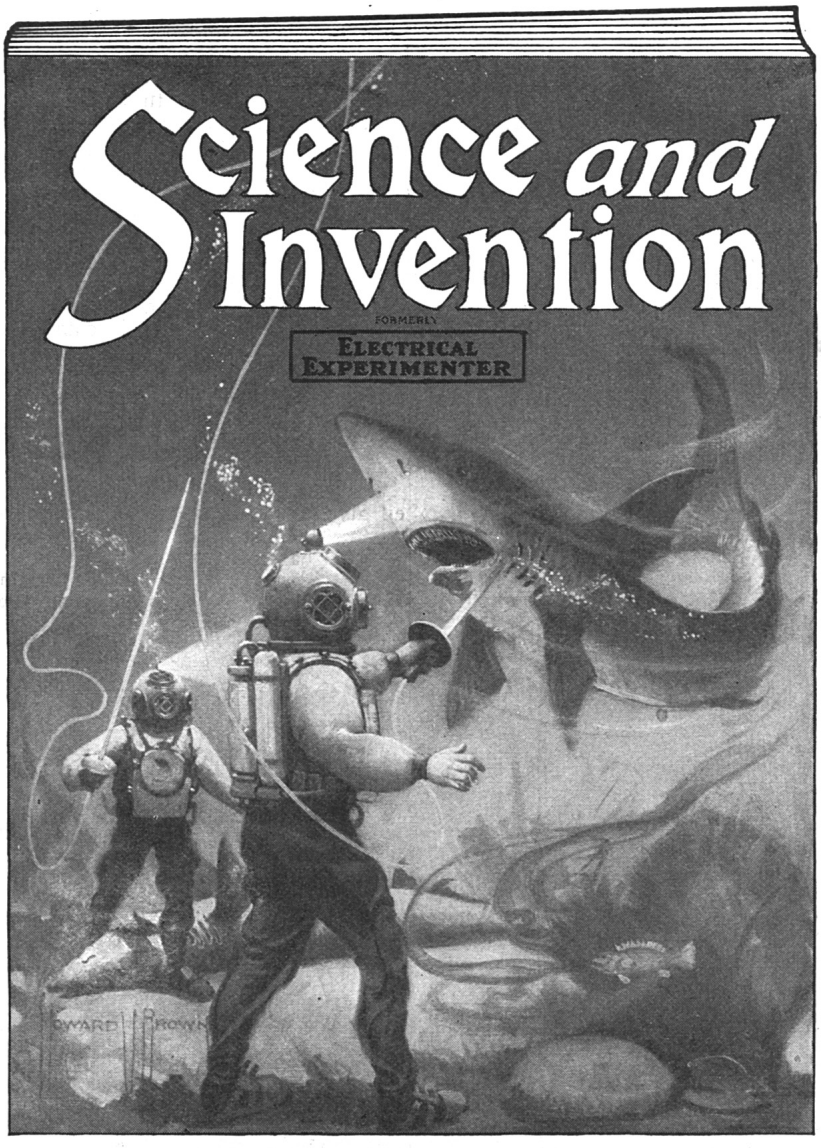
But your average experimenter wants more than experiments. He wants to know the latest word in science, the newest invention, the latest developments in the realm of human endeavor. He wants to know what the scientists and his fellow workers are doing the world over, and he wants these facts in plain English, adequately illustrated.

This was made plain to us during our second year, and we began adding a "general" section, being urged insistently to do this by our readers. We kept on adding department after department, such as physics, chemistry, astronomy, etc., until by the end of the fourth year, our title *"Electrical Experimenter"* had become a misnomer. While we have constantly kept on increasing all of our electrical departments, keeping true to our original editorial policy, there came a period a few years ago, when thousands of general readers — the "non-experimenters," suddenly discovered a strong appetite for our magazine, even tho its title did not fully describe its contents.

The business man, the manufacturer, the doctor, the professor, the student and countless others found in the ELECTRICAL EXPERIMENTER an intellectual gold mine, second to none. The ELECTRICAL EXPERIMENTER always has and always will appeal to the thinking class.

When we found out two years ago that the general public began buying the magazine, we added the sub-title "SCIENCE and INVENTION," which portrayed the contents of the magazine more adequately. There was, of course, no change of policy at that time, except that we kept on enlarging and bettering the magazine as you well know. We kept all of our old friends and supporters—the ones who buy the ELECTRICAL EXPERIMENTER mostly for the experimental section, and we added besides many thousands of new readers who derived their greatest pleasure from the other "general science" departments.

But we are out for the half million mark, because we know from past experience that the greater the circulation the better we can make the magazine, the more text we can give, the better we can satisfy *all* readers.



But our old misnomer, the title ELECTRICAL EXPERIMENTER, was constantly in our way. To be sure, if we could once get a man to take a peep at the inside of the magazine, nine-tenths of our battle was won. But the general public would look at our cover and the cryptic words ELECTRICAL EXPERIMENTER, would shoo them away!

For August

Electrocuting Sharks. By H. Gernsback.

The Master Key—A bit of Scientific Fiction that Will Hold Your Interest to the Very Last Word. By Charles S. Wolfe.

A Popular Explanation of the Fourth Dimension and Hyper-Space. By Frank M. Gentry.

How the Loud-Speaking Telephone Served the Republican Convention.

First Electric Welded Building. By H. B. Payne, Electric Welding Engineer.

Movies of the "Unseen"—How Students Can Now Actually see Electric Currents in Electro-Magnets and Dynamos. By Jerome Lachenbruch.

Man-Made Rubies — How the Chemist Constructs Synthetic Rubies Which Cannot be Told from a Genuine Stone. By O. Ivan Lee, B. Sc. Chemistry.

Of course, we could have stuck to the old title and in years the public would have come to us in increasing numbers, but at a large and useless cost to us. So we decided to reverse our titles, and beginning with the August issue, your magazine will be known officially as "SCIENCE and INVENTION." As a sub-title we will continue with our good old standby ELECTRICAL EXPERIMENTER, as you can readily see from the accompanying illustration, which represents our *August* cover.

There will, of course, be no change in our Editorial policy. We will continue bettering and enlarging the magazine just as we have always done. We will have more pages and better ones for the experimenter, and more and better Science and Invention pages for the general reader in quest of information and who can not properly exist in this changed world without keeping abreast of everyday science.

ELECTRICAL EXPERIMENTER (*Science and Invention*) has become an American institution today. It is probably the most authoritative magazine of its kind in the world. It reaches every land of the globe and is read everywhere. Our articles have and are being translated constantly into French, German, Italian, Spanish, Japanese, Dutch and even Arabian. In America there is no first-class periodical or newspaper that does not very frequently quote from our pages. Publications such as *Literary Digest,* New York *Times,* all of the Hearst papers, New York *World,* New York *Sun and Herald,* New York *Tribune,* New York City *Mail,* New York *Evening Post,* Chicago *Tribune,* Philadelphia *Inquirer,* Boston *Post,* St. Louis *Globe-Democrat,* Cincinnati *Enquirer,* Cleveland *Plain-Dealer,* San Francisco *Chronicle,* Pittsburgh *Gazette-Times,* Boston *Globe,* Minneapolis *Star,* Albany, N. Y., *Argus,* De Moines *Capital,* Washington, D. C., *Times,* Syracuse, N. Y., *Herald,* Pittsburgh *Press,* Dallas, Texas *Times-Herald,* Rochester, N. Y., *Herald,* Lancaster, Pa., *Intelligencer,* Rome, N. Y., *Sentinel,* Sterling Vermont *Free Press,* Attleboro *Sun,* Knoxville *Tribune,* Buffalo *Commercial,* Atlanta *Constitution,* Baltimore *News,*—nearly every Sunday magazine newspaper section, and hundreds of other smaller papers, too numerous to mention, *constantly* quote from our columns.

There is, of course, a good reason for this. ELECTRICAL EXPERIMENTER (*Science and Invention*) "has the goods." Moreover, your magazine almost invariably has the *news first*—the same items appearing later in other periodicals. That is why we lead and why *Science and Invention* shall continue to lead and to serve you.

We have won your confidence in the past, and we believe that we will keep it.

We thank you for your past generous support and we know that you will not find us wanting. —*The Publishers.*

Popular Astronomy

By ISABEL M. LEWIS, M.A.

of U. S. Naval Observatory

The Motions of the Heavenly Bodies

THREE hundred and twenty years ago Giordano Bruno was burned at the stake for his audacity in believing in the existence of other worlds. A few decades later the famous astronomer Galileo was forced to publicly recant his belief that the earth moved. Yet the truth could not long be suppress by such means, and since those dark days man's advance in knowledge has been so rapid that it seems to us to-day in this wonderful age of scientific discovery almost inconceivable that man ever believed that the earth, a tiny planet of a vast solar system, was "the hub of the universe," the fixt and immovable center about which revolved all the heavenly bodies. Very reluctantly, however, and with bitter feeling in the light of overwhelming evidence man finally gave up his long cherished idea of terrestrial importance, and when finally forced to move his fixt center of the universe, he moved it only so far as the comparatively nearby sun.

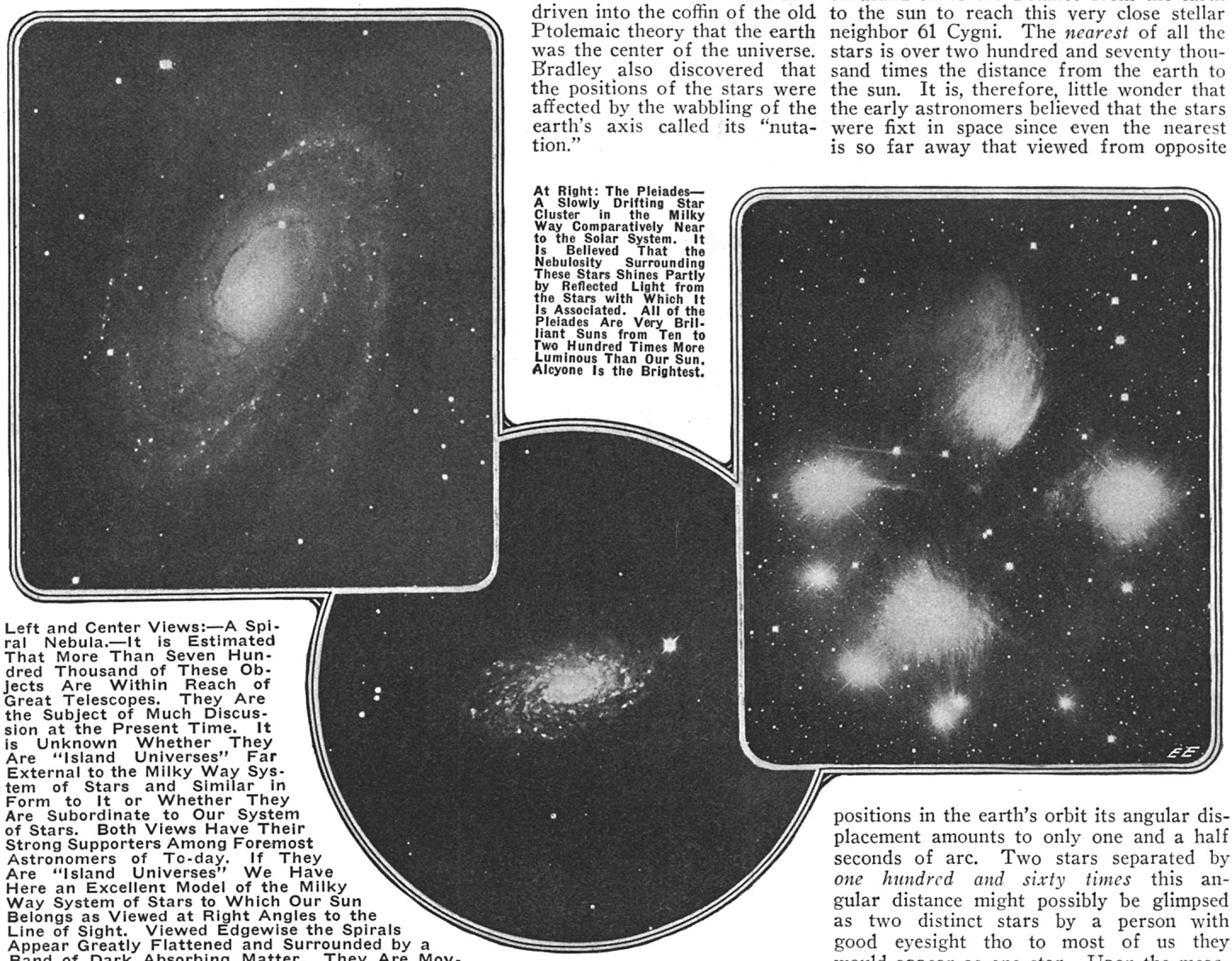
This center he then regarded as fixt in space, still holding to his belief that the stars, set in an imaginary celestial sphere were "fixt" in space as well and all at the same distance from the sun. So, scarcely two hundred years ago we find that the astronomer Bradley was endeavoring to measure this common distance of the "fixt stars." Tho he failed in this attempt he made the important discovery that the observed positions of the stars are affected by the fact that the velocity of light is not infinite but takes a definite finite interval of time to travel a given distance. As a result the stars always appear displaced in the direction of the earth's motion around the sun, the amount of the displacement depending upon the velocity of the earth and the velocity of light. This "aberration of light," as it is called, furnished additional proof that the earth revolves about the sun and was one more nail driven into the coffin of the old Ptolemaic theory that the earth was the center of the universe. Bradley also discovered that the positions of the stars were affected by the wabbling of the earth's axis called its "nutation."

Altho in the days of Bradley neither the methods of observation nor the instruments were sufficiently accurate to show the minute shifts in the positions of the stars that reveal the individual motions of the stars and the distances of those nearest to us, yet the discovery of the two large displacements in the positions of all the stars, due to the aberration of light and the nodding of the earth's axis were of the greatest value, for they were a necessary step in the direction of the precise measurements of modern times. It is only thru measurements of the greatest refinement and accuracy that it is possible to detect the motions and distances of the stars and to discover the wonderful truths about the nature and structure of the universe that they are revealing to us to-day.

After unsuccessful attempts extending over several centuries the distance of one of the nearest stars, the faint 61 Cygni, as it is catalogued, was finally determined by the astronomer Bessel in the year 1838.

This star is about ten light years distant from the earth which places it about six hundred and thirty thousand times farther away from us than the sun: that is, we would have to travel six hundred and thirty thousand times the distance from the earth to the sun to reach this very close stellar neighbor 61 Cygni. The *nearest* of all the stars is over two hundred and seventy thousand times the distance from the earth to the sun. It is, therefore, little wonder that the early astronomers believed that the stars were fixt in space since even the nearest is so far away that viewed from opposite positions in the earth's orbit its angular displacement amounts to only one and a half seconds of arc. Two stars separated by *one hundred and sixty times* this angular distance might possibly be glimpsed as two distinct stars by a person with good eyesight tho to most of us they would appear as one star. Upon the measurement of such minute angles depended a knowledge of the distances of the nearest stars.

It is to Sir William Herschel that we owe the discovery, more than a hundred years ago, of the motion of the sun thru the universe. From the consideration of a long series of observations of the positions of the stars this famous astronomer discovered that the stars in the direction of the constellation Hercules were separated by much greater angular distances than the stars diametrically opposite in the heavens. In other words, the stars were spreading



At Right: The Pleiades—A Slowly Drifting Star Cluster in the Milky Way Comparatively Near to the Solar System. It Is Believed That the Nebulosity Surrounding These Stars Shines Partly by Reflected Light from the Stars with Which It Is Associated. All of the Pleiades Are Very Brilliant Suns from Ten to Two Hundred Times More Luminous Than Our Sun. Alcyone Is the Brightest.

Left and Center Views:—A Spiral Nebula.—It is Estimated That More Than Seven Hundred Thousand of These Objects Are Within Reach of Great Telescopes. They Are the Subject of Much Discussion at the Present Time. It is Unknown Whether They Are "Island Universes" Far External to the Milky Way System of Stars and Similar in Form to It or Whether They Are Subordinate to Our System of Stars. Both Views Have Their Strong Supporters Among Foremost Astronomers of To-day. If They Are "Island Universes" We Have Here an Excellent Model of the Milky Way System of Stars to Which Our Sun Belongs as Viewed at Right Angles to the Line of Sight. Viewed Edgewise the Spirals Appear Greatly Flattened and Surrounded by a Band of Dark Absorbing Matter. They Are Moving in the Edge-wise Directions with an Average Velocity That is Twenty-five Times the Average Velocity of the Stars or 480 Miles Per Second. They Are the Most Rapidly Moving Bodies in the Heavens and Lie Exterior to the Milky Way in the Direction of Its Poles. Their Distances Are Not Yet known.

apart in one portion of the heavens and crowding together in the opposite direction and he rightly interpreted this to mean that the sun was moving in the direction of the constellation of Hercules. It was not until the spectroscope was applied to the study of the heavens in the latter part of the nineteenth century that the amount of this motion of the sun was found to be about twelve and a half miles per second or four times the distance from the earth to the sun in a year.

It is to Sir William Herschel that we also owe the discovery of binary systems of stars in which two stars are in mutual revolution about their common center of gravity.

Our first conception of the immensity and grandeur of the universe dates from the time of the older Herschel only a century or so ago. The mysterious nebulæ and star clusters were then discovered, the wonders of the Milky Way were explored, a new planet and satellites in our own solar system were discovered. It was found that the sun and the stars as well as the planets were in motion. Neither sun nor earth could be regarded any longer as a fixed point in the universe.

With the application of the spectroscope to the study of the heavens toward the end of the nineteenth century the key to a treasure-house of knowledge was placed in the hands of the astronomers of modern times and as a result we are now learning more, in a few decades, about the wonders and mysteries of the heavens than was granted to man to learn in centuries of earlier endeavor. Yet it is the feeling of the astronomer of to-day that he is only standing on the threshold of knowledge and that the greatest of all discoveries, that of the nature of matter and of time and space is yet to be made.

It is the spectroscope that tells us so many wonderful facts about the motions of the stars, nebulæ and star clusters. It tells us also practically all we know about the physical condition of our own sun and of the other suns of the universe, their temperature and age, and the peculiarities of their atmospheres.

Some of the most wonderful astronomical discoveries that have been made in the past few years relate to the distribution and velocities of the heavenly bodies as revealed by the spectroscope.

From a systematic study of all the various types of stars it has been found that the velocity with which a star is moving thru space is intimately associated with its type of spectrum (see Table I). The most slowly moving of all stars are the extremely hot bluish Orion stars with an average velocity of eight miles per second. The most rapidly moving stars are the deep-red stars with an average velocity of twenty-one miles per second, and there is a regular progression of velocity with type for all stars. The reason for this close association of type of spectrum with velocity still remains undiscovered.

The spectroscope has also told us some astonishing facts in recent years about the velocities of the spiral nebulæ.

According to the measurements of Dr. V. M. Slipher of the Lowell Observatory, these mysterious objects are moving with the tremendous average velocity of *four hundred and eighty miles per second,* which exceeds the average velocity of the stars fully twenty-five fold. They possess, moreover, internal motions of rotation that are almost as high as their velocities thru space. These results have been corroborated, also, by other observers and they strongly support the theory that spiral nebulæ are far distant objects of enormous size and mass exterior to our own universe of stars and similar to it in form.

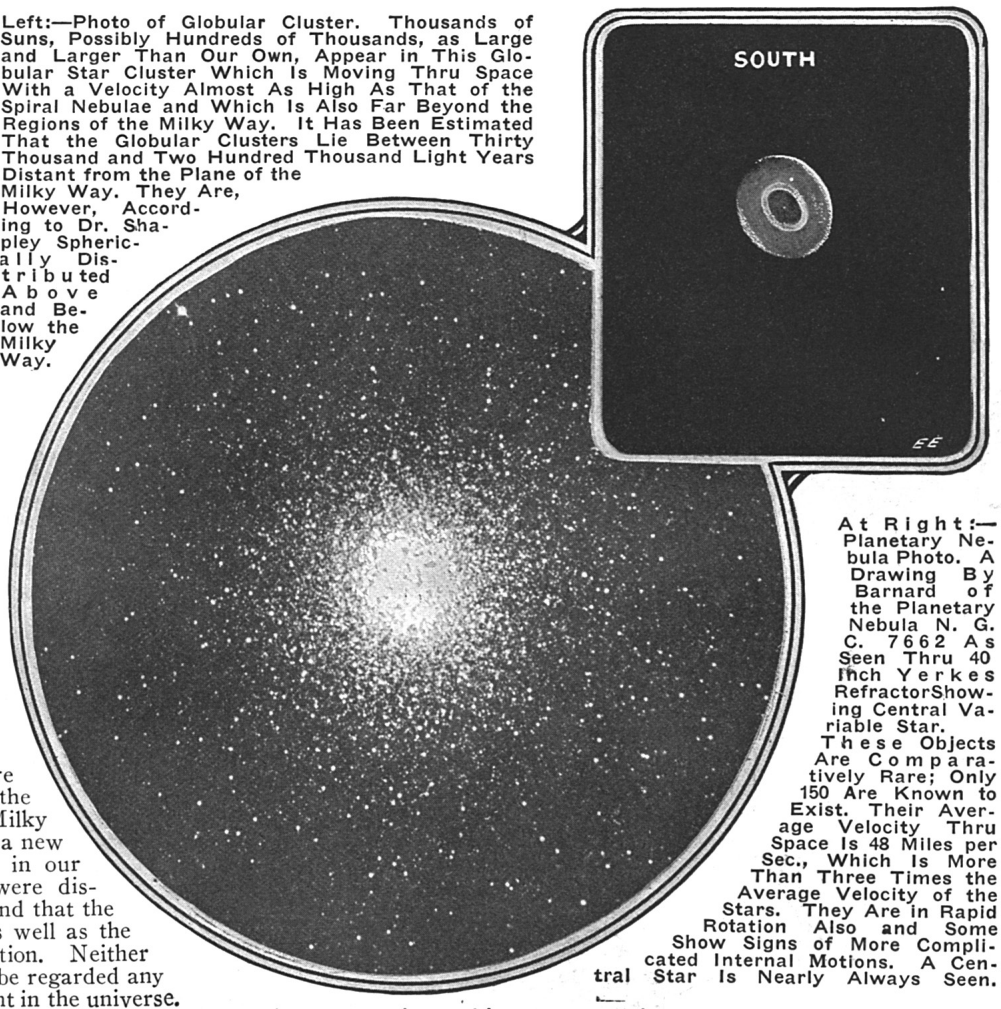
Certain observers have gone so far as to attempt to determine the motion of our own stellar universe as a whole relative to these spirals and have obtained the tremendous velocity of three hundred and seventy-five miles per second. For the universe of the "fixt stars" and the immovable sun or earth of the astronomers of a few centuries ago we find that modern astronomical discovery is substituting the vision of a universe of inconceivable grandeur and immensity in a state of ceaseless flux and change.

Our earth, an atom spinning about on its axis and revolving rapidly around a huge sun that is equal in volume to more than a million earths, is carried onward with this sun thru a vast universe of suns.

Only an average-sized star among several hundred million other stars is this huge sun of ours moving with its planet family thru the regions of the Milky Way, where are to be found not only moving clusters and groups of stars, speeding along their way in obedience to the laws of motion of the system to which they belong, but also strangely formed nebulæ covering vast stretches of space, whirling and seething internally and shining with mysterious light, and still other stretches of dark absorbent matter shutting off the rays of suns beyond.

The extent and form of this enormous system of stars and nebulæ and the laws that govern the motions of its individual members are among the problems that the astronomers of today are attempting to solve. On both sides of these regions of the Milky Way wherein lies our own solar system, lie other vast systems, such as the globular star clusters, composed of thousands, possibly hundreds of thousands, of suns, the Magellanic clouds which resemble detached portions of the Milky Way and the much discussed spiral nebulæ, the possible "island universes" similar to our own. All of these external systems are characterized by extraordinarily high velocities. Not only is their speed on the average twenty-five times as high as the speed of the stars in the Milky Way system of stars, but they are also in extremely rapid rotation. Assuming that these vast systems are independent of and analogous to our own universe of suns, we are led to the conclusion that our sun is but a stellar atom in a huge spiral star system flattened toward the plane of the Milky Way and that the individual

(*Continued on page* 312)



Left:—Photo of Globular Cluster. Thousands of Suns, Possibly Hundreds of Thousands, as Large and Larger Than Our Own, Appear in This Globular Star Cluster Which Is Moving Thru Space With a Velocity Almost As High As That of the Spiral Nebulae and Which Is Also Far Beyond the Regions of the Milky Way. It Has Been Estimated That the Globular Clusters Lie Between Thirty Thousand and Two Hundred Thousand Light Years Distant from the Plane of the Milky Way. They Are, However, According to Dr. Shapley Spherically Distributed Above and Below the Milky Way.

At Right:—Planetary Nebula Photo. A Drawing By Barnard of the Planetary Nebula N. G. C. 7662 As Seen Thru 40 Inch Yerkes RefractorShowing Central Variable Star. These Objects Are Comparatively Rare; Only 150 Are Known to Exist. Their Average Velocity Thru Space Is 48 Miles per Sec., Which Is More Than Three Times the Average Velocity of the Stars. They Are in Rapid Rotation Also and Some Show Signs of More Complicated Internal Motions. A Central Star Is Nearly Always Seen.

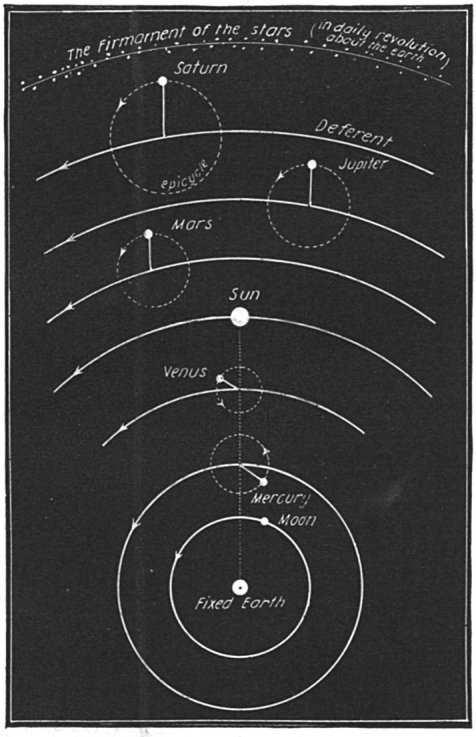
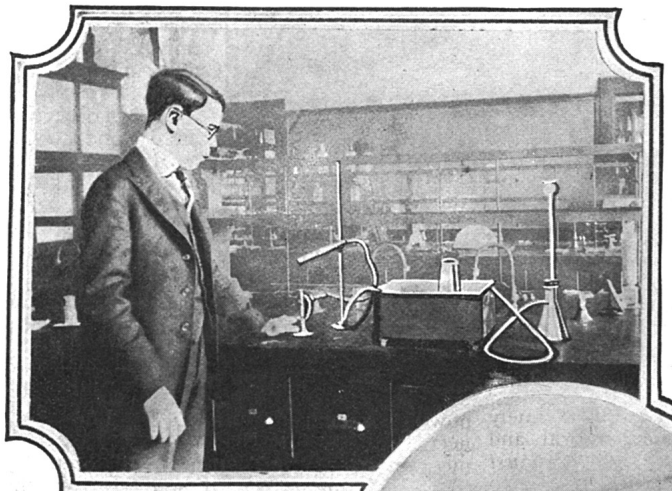


Diagram I.—The Motions of the Heavenly Bodies As Represented By the Ptolemaic System of the Universe and as Universally Taught and Accepted for Over Fourteen Centuries (150 A. D. to 1600 A. D.). The Earth Was the Fixt Center of the Universe About Which Revolved in Order, the Moon, Mercury, Venus, Sun, Mars, Jupiter and Saturn.

Practical Chemical Experiments

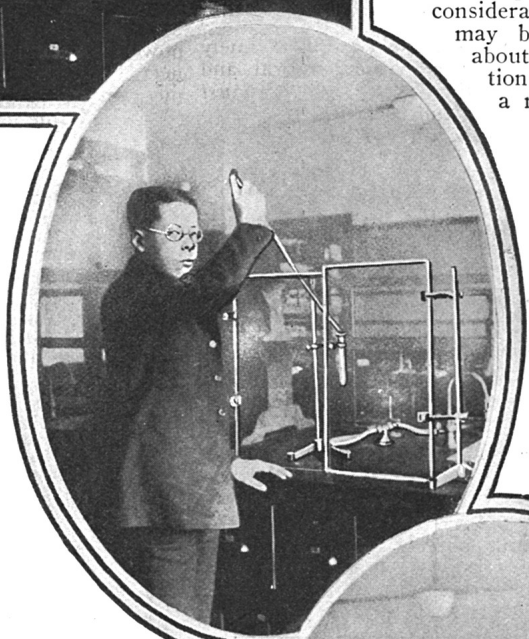
By PROF. FLOYD L. DARROW

HOME-MADE FIREWORKS.

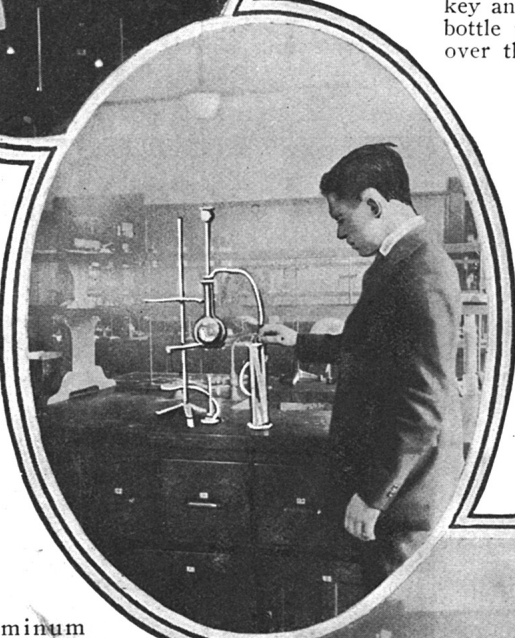


Generating and Collecting Hydrogen and Oxygen for Explosion Experiments. The Bottle Is Filled With Water, inverted, and the Gas Collected by Displacement Method. Two Parts of Hydrogen by Volume and One of Oxygen, Are Used.

OF all the interesting demonstrations possible for the amateur chemist, there are none that make a stronger appeal to his imagination than those which have to do with fireworks and explosions. And now, too, that the old-fashioned Fourth of July celebration has been largely banned, there is all the more reason for having an elementary knowledge of the chemistry of "Pyrotechnics." Therefore, I propose to give in this number a large quantity of ammunition, suitable for punctuating the outbursts of youthful patriotism and for satisfying that very legitimate desire for explosions and Noise!



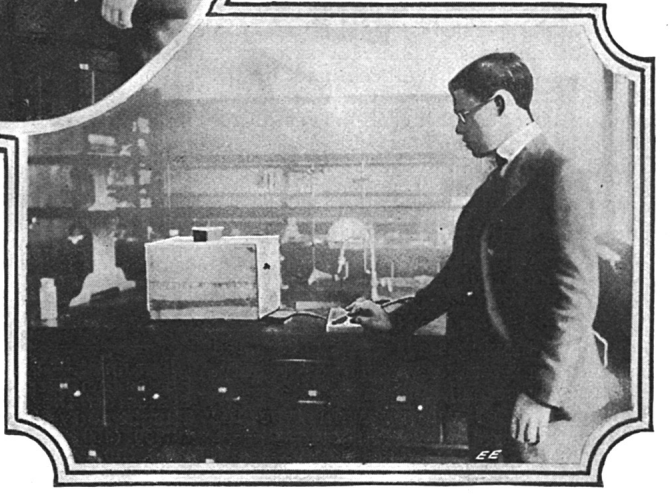
Exploding a Mixture of Aluminum Dust and Sodium Peroxid With a Drop of Water. Two Glass Plates Are Held in a Vertical Position by Means of Clamps in Front of the Test-Tube Containing the Mixture.



Generating Chlorin Gas by Heating a Mixture of Manganese Dioxid and Hydrochloric Acid and Collecting in Cylinder by Air Displacement Method. This Will Then Be Used for the Hydrogen Chlorin Explosion Experiments.

Phosphorus and Potassium Chlorat: For a good roof-lifting explosion that will satisfy every requirement of a Fourth of July stunt, try the following: On a brick or anvil place as much powdered potassium chlorat as you can get on the point of a small knife blade. Then over this pour a few drops of a strong solution of yellow phosphorus in carbon disulfid. Wait for the solution to evaporate. This will leave phosphorus in finely divided state thruout the potassium chlorat powder and presently a very sharp report will occur. In case the explosion is slow in coming, strike the mixture with a hammer held in the gloved hand but under no circumstances touch it with the fingers. To make the solution of phosphorus, pick up a piece about the size of a pea with pincers, dry it gently with a piece of filter or blotting paper and quickly drop it into a small stoppered bottle of carbon disulfid. Shake for a few moments and the solution will be ready for use. Always keep phosphorus under water, cut it under water, and *under no circumstances touch it with the fingers.* In case of an accidental phosphorus burn, bathe it immediately with potassium permanganat solution and continue to do so at frequent intervals.

Explosion of Aluminum Powder and Sodium Peroxid: Another explosion of considerable violence may be brought about by the action of water on a mixture of aluminum powder and dry sodium peroxid. Make a mixture of the two powders in a dry test-tube and clamp the test-tube to a ring stand or other support placed behind a glass screen. See Fig. 1. Then allow one drop of water to fall on the mass from the end of a long glass tube. The water and sodium peroxid react to form oxygen which unites with the hydrogen liberated by the action of the resulting sodium hydroxid on the aluminum. The result is an explosion, *which shatters the test-tube!*



Exploding Hydrogen and Nitrogen by Means of an Electric Current, Weighted Protective Boxes Are Placed Around the Flask Containing the Mixture, so as to Prevent Injury Due to the Force of Explosion.

Explosion of Lead Nitrat and Sulfur: Place in an unglazed mortar or on an anvil equal quantities of finely powdered lead nitrat and flowers of sulfur. Holding a pestle or hammer in the gloved hand, rub the mixture vigorously and the result will be a rapid oxidation of explosive violence.

Explosion of Hydrogen and Oxygen: Hydrogen and oxygen mixed in proper proportions unite with tremendous energy, accompanied by a very loud report. To prepare the oxygen and hydrogen arrange apparatus as shown in Fig. 2. Fill an 8-ounce bottle or a small flask with water and invert it in a basin of water. First start the hydrogen generator, using zinc and dilute sulfuric acid and fill the bottle two-thirds full of hydrogen. Then start the oxygen generator, having in the tube a mixture of potassium chlorat and manganese dioxid, and fill the remaining one-third of the bottle.

Keeping the bottle mouth downward, lift it from the basin and quickly insert in it a solid rubber stopper carrying about it a loop of No. 30 iron wire. To the ends of the wire fasten two 3-foot lengths of No. 18 copper wire and connect them with a key and a half-dozen dry cells. Place the bottle under a small thin walled box and over this place a larger heavier box raising it on blocks about an inch from the floor or table as shown in Fig. 3. Close the circuit and the iron wire, heated to incandescence by the large flow of current, will ignite the mixture of hydrogen and oxygen. The explosion will give a very loud report and will probably shatter the inner box. (It will be safest not to connect the cells until the bottle has been covered.)

Nitrogen Iodid: An explosive of extreme sensitiveness and one which will give no end of amusement can be made from the reaction of iodin and strong ammonia water. Place a few cubic centimeters of the

strongest ammonia in the bottom of a test tube and mix with it an equal quantity of very concentrated tincture of iodin. The tincture of iodin can be made by shaking crystals of iodin with a little alcohol and continuing to do so until a considerable

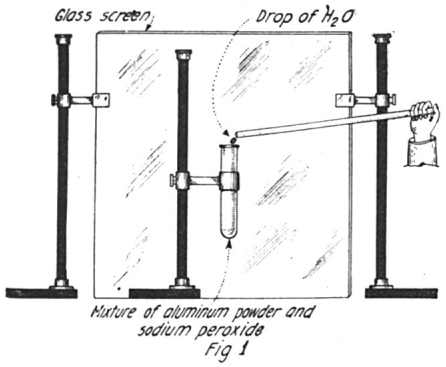


Fig. 1—Technique Employed in Exploding Aluminum Powder and Sodium Peroxide by Means of a Drop of Water.

quantity has been dissolved. When ammonia and iodin solutions are mixed, a precipitate of nitrogen iodin in the form of a black powder immediately separates.

This compound, however, is not at all explosive unless it is thoroly dry. But in that condition it is exceedingly unstable and only a very small amount is necessary to demonstrate this instability and the large quantity of energy that it contains. Therefore, shake up the contents of the test tube and pour successive small portions onto folded filter papers. To dry these will require at least two hours.

When dry tickle one of the papers with a long feather and even this slight friction will cause the nitrogen iodid to explode with a sharp report.

Blow upon another portion thru a long glass tube and the sudden puff of air will cause it to explode.

Hold one of the papers with the tongs and quickly depress it over a Bunsen flame. The violence of the explosion will extinguish the flame.

If placed on chairs or tables of a room any unusual jar like that caused by the shutting of a door or heavy treading upon the floor will cause the iodid to explode.

Always make these explosions at long range and when you are thru with them be sure that none of the stuff is left lying about.

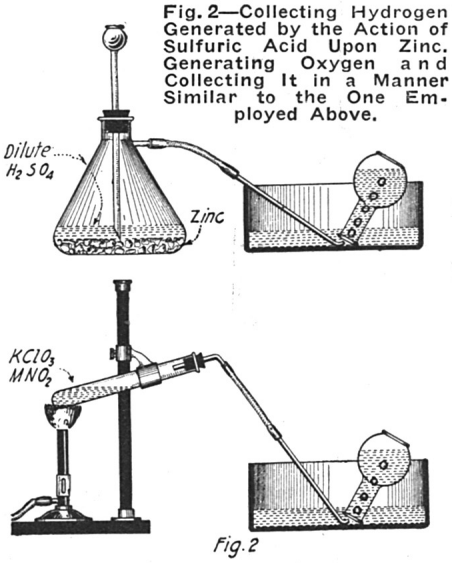
Old-Fashioned Gunpowder: Before the days of modern high power explosives gunpowder was the product of sulfur and charcoal, two easily oxidized substances, together with the strong oxidizing agent, potassium nitrat. Therefore, to prepare powder of this sort, thoroly mix 30 grams of finely pulverized potassium nitrat with 5 grams each of powdered charcoal and flowers of sulfur. Place the mixture on a square of asbestos and ignite with a long wax taper.

Spontaneous Combustion: Over a filter paper or some piece of absorbent paper pour a little of the solution of carbon disulfid and yellow phosphorus used in the first demonstration described in this article. Then wave the paper to and fro in the air and in a few moments it will begin to smoke and spontaneously take fire. As the carbon disulfid evaporates, it leaves the phosphorus in a finely divided state over the surface of the paper, and its rapid oxidation soon generates enough heat to bring the phosphorus to its kindling temperature.

Touch Paper: For use as fuses in a number of the ignition experiments in this article, a quantity of touch paper will be found desirable. It can be made by saturating strips of filter paper or blotting paper in a strong solution of potassium nitrat and allowing them to dry. One of these strips will burn like the fuse of a firecracker and it cannot be extinguished by blowing. See Fig. 4.

Red Fire: In separate containers finely powder 1 gram of potassium chlorat and 11 grams of strontium nitrat. (*They must not be powdered together.*) Mix them with 4 grams of flowers of sulfur and ½ gram of lampblack. Place the mixture on an asbestos square and insert in the top of the conical heap a fuse of touch paper. Upon ignition an intensely red flame results and one of great brilliancy in a darkened room.

Fig. 2—Collecting Hydrogen Generated by the Action of Sulfuric Acid Upon Zinc. Generating Oxygen and Collecting It in a Manner Similar to the One Employed Above.



Green Fire: Observing the same precautions as in the previous experiment, mix 3 grams of pulverized potassium chlorat with 8 grams of finely powdered barium nitrat and 3 grams of flowers of sulfur. Place the mixture on asbestos and ignite with touch paper. A brilliant green results.

Purple Fire: Mix in finely powdered condition 2 grams of copper sulfate, 2½ grams of flowers of sulfur and 15 grams of potassium chlorat. Ignite on asbestos with touch paper or a long taper.

A blue flame may be obtained by igniting a mixture of 2 grams of powdered charcoal, 2 grams of cupric chlorid and 4 grams of potassium chlorat.

Flash Powder: A flash light of blinding intensity can be produced by the ignition of a mixture of equal parts by volume of finely powdered potassium chlorat and magnesium dust. *In lighting this mixture, however, never attempt to do so with a match.* Instead use a long wax taper or a piece of touch paper. The combustion comes with great suddenness and otherwise a severe burn would be incurred. Flash powder made in this way will give excellent results in photography work.

Ignition by Electricity: A very safe method and an interesting one, too, for igniting a combustible mixture is by means of electricity. Cover a six-inch square of wood with asbestos paper and mount on it two brass binding posts. Between the posts

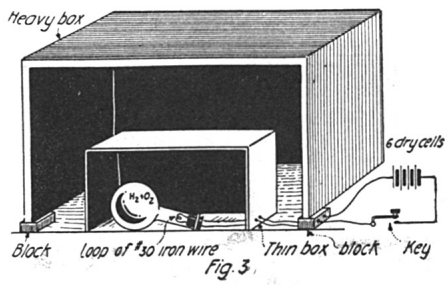


Fig. 3—Showing the Position of the Flask and the Protective Boxes, Preparatory to Closing the Circuit Which Will Explode the Mixture of Hydrogen and Oxygen in the Flask.

insert a piece of No. 30 iron wire and on this wire place the heap of combustible powder, whatever it may be. Then connect with the binding posts by means of medium size copper wire a half dozen dry cells, inserting a key of some sort in the circuit. Upon closing the key the iron wire will be heated to incandescence and the mixture will ignite. See Fig. 5.

A Sparkler: If a stick of potassium chlorat is rubbed on the igniting surface of a safety match box, a shower of sparks will be thrown off.

Combustion in Ozone: In the bottom of a tumbler place 1 gram of powdered potassium permanganat and moisten it with a few drops of water. Into the bottom of the tumbler pour 2 cubic centimeters of concentrated sulfuric acid and follow it with 1 cubic centimeter of alcohol poured from a test-tube attached to the end of a long stick as in Fig. 6. A combustion of almost explosive violence follows, due to the presence of ozone.

Sift a pinch of sulfur into another tumbler prepared in the same way and it will immediately be ignited.

Into a third tumbler of the mixture dip a glass rod and touch it to the wick of an alcohol lamp. It will ignite at once.

Combustion of Sugar and Potassium Chlorat: Being careful to avoid friction carefully mix equal quantities of finely powdered potassium chlorat and cane sugar. Then saturate a small piece of asbestos paper with concentrated sulfuric acid and holding it with the tongs drop it on the mixture placed on a square of asbestos board. A very rapid combustion accompanied by an intensely blue flame results.

Explosion of Sodium Peroxid and Charcoal: Mix equal quantities of dry sodium

(*Continued on page* 315)

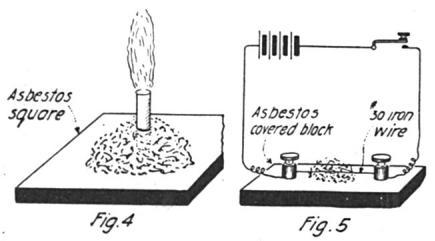


Fig 4—The Very Simple Method Employed in Igniting Powder With Touch Paper.
Fig. 5—Igniting Flash Powder by Means of Electricity.

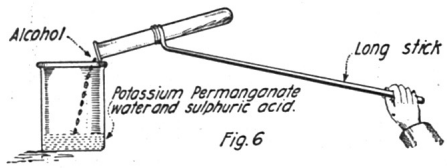


Fig. 6—Combustion of Alcohol in an Atmosphere of Ozone. The Alcohol Is in a Test-Tube at the End of a Protective Stick.

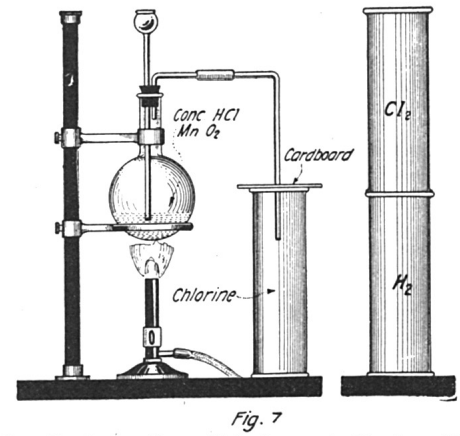
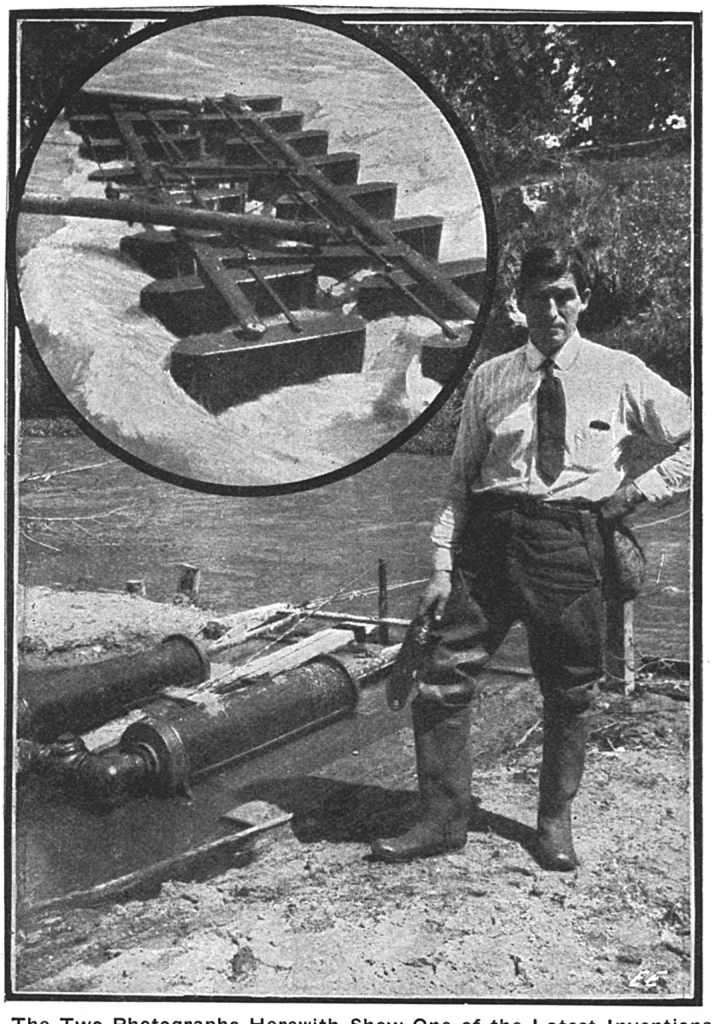


Fig. 7—Generating Chlorin and Placing It Into a Cylinder by Displacing the Air, Chlorin Being a Much Heavier Gas, Pours Downward Very Readily.

Electricity From Water-Power

By H. WINFIELD SECOR



The Two Photographs Herewith Show One of the Latest Inventions in Water-Power Utilization, as Devised by Mr. F. L. Gilman, of Los Angeles, Cal. The Device Is so Constructed That When Anchored in Midstream the Pivoted Floats, of Which There Are Two Series as Shown in the Photos, Are Caused to Sway Back and Forth, and in Doing so This Action Causes the Operation of Two Pistons. The Pistons in the Model Here Illustrated Have a Stroke of 22 Inches and Pump 80 Gallons of Water Per Minute Thru a Three-Inch Pipe to a Height of 18 Feet. See Also the Diagram Below.

A NEW WAVE AND CURRENT MOTOR

Considering the development of water-power from streams, rivers and even the motion of the ocean waves, we may before going further take notice of the invention shown in two of the accompanying photos and also in diagram at Fig. 1. This new water-power plant is the invention of Mr. F. L. Gilman, of Los Angeles, Cal. It is so constructed that when anchored in midstream the pivoted floats, of which there are two, are caused to sway back and forth, and in doing so this action causes the operation of two pistons. The pistons of the model here shown have a stroke of 22 inches and pump 80 gallons of water a minute thru a three-inch pipe to a height of 18 feet.

In the diagram Fig. 1 a modified arrangement of this water-power engine is shown, according to the writer's idea, whereby the alternate action of each of the two or more pistons is caused to compress air. Each pulse of air from the respective cylinders is forced into a large air storage tank. From here the comprest air under a considerable pressure enters the pneumatic engine or motor, which in turn may drive a dynamo or operate machinery directly connected to the prime mover. In this way a steady pressure of air is available at all times to operate the pneumatic engine or motor which would not be the case if the fluctuating air pulses coming directly from the air pumps on the shore were utilized directly.

This scheme can also be utilized in the way Mr. Gilman is now using it; that is, by pumping the water, but instead of pumping it into a reservoir for drinking or other purposes a large battery of these pumps could be employed, all of them pumping water into a large tank or reservoir elevated at an appreciable height, so as to give the water a good head pressure. The water can then be taken from this reservoir thru a suitable penstock or pipe to a water turbine, and in this way the intermittent character of the water impulses transmitted from the wave-operated shore pumps would be eventually transformed into a steady power, owing to the great quantity of water impounded into the reservoir as becomes clear on second reflection.

COMPUTING THE HORSE-POWER OF STREAMS.

Resuming the subject of developing water-power by wheels or turbines, we may turn to the commonest arrangement met with in practise, that of harnessing a brook or small river to a turbine. One of the simplest ways of doing this is seen at Fig. 2, where a dam is placed across the stream far enough up-stream from the turbine to get sufficient head in feet to operate it. Every foot head of water creates a pressure of .433 pound per square inch. Hence a 20-foot head or drop in the water would give 8.66 pounds pressure per square inch, etc. This relation is clearly shown in table No. 1 at the end of this paper.

One of the first considerations in placing a water-power plant of any size is to see whether or not a sufficient quantity of water is available in dry seasons, etc., to operate the wheels or turbines. Firstly, the gallons or cubic feet of water per second or minute required to operate the turbine is required to be known. This is given in the tables here presented, or also it may be obtained from the manufacturers of turbine wheels.

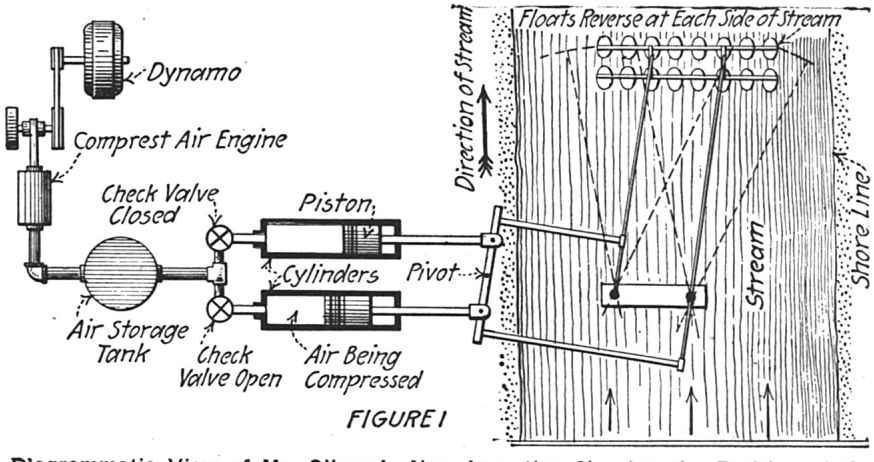
Secondly, the amount of water available per second or minute, etc., from the brook or stream is to be ascertained if the plant is to run regularly, regardless of dry seasons and the like. We know that the cubic feet of water flowing per second is found by multiplying its velocity by a given point in feet per second by the cross-sectional area of the stream at that point in square feet or the "wet-perimenter" as it is termed.

Hence, if we place a wood float consist-

How to Compute the Horsepower of Streams and Build Water-Wheels

AS the Springtime rolls around, the young experimenter's fancy lightly turns not to "thoughts of love," as the poet has it, but frequently to more scientific thoughts, and where the dreamy thoughts of Spring are influenced by a babbling brook, the minds of those with a scientific trend cannot resist the temptation to harness the power constantly going to waste in brooks, rivers and ponds.

Some time ago, or to be exact, in the July and August, 1916, issues of this journal, the writer had the pleasure of presenting an exhaustive article dealing with the design and the construction of water-wheels both large and small, as well as complete electric generating plants driven by water-power. In the present discussion the highly technical and mathematical features necessary in carrying out a first-class design of high efficiency water-wheel will be ignored, and those interested in these details can consult their back numbers or look the matter up in the files at their local library.



Diagrammatic View of Mr. Gilman's New Invention Showing the Position of the Anchored Float Levers in Midstream and How the Alternate Swinging to and fro of the Floats Cause the Pistons to Work in and out of the Two Cylinders. Instead of Pumping Water, the Author Suggests the Pumping of Air Into a Storage Tank, Which Could Then Operate a Comprest Air Engine and Dynamo, to Supply Electric Lights, Etc. The Floats Reverse When They Reach One Side of the Stream, and Then Swing to the Other Side; Then Reverse Again and Go Back, Et Cetera.

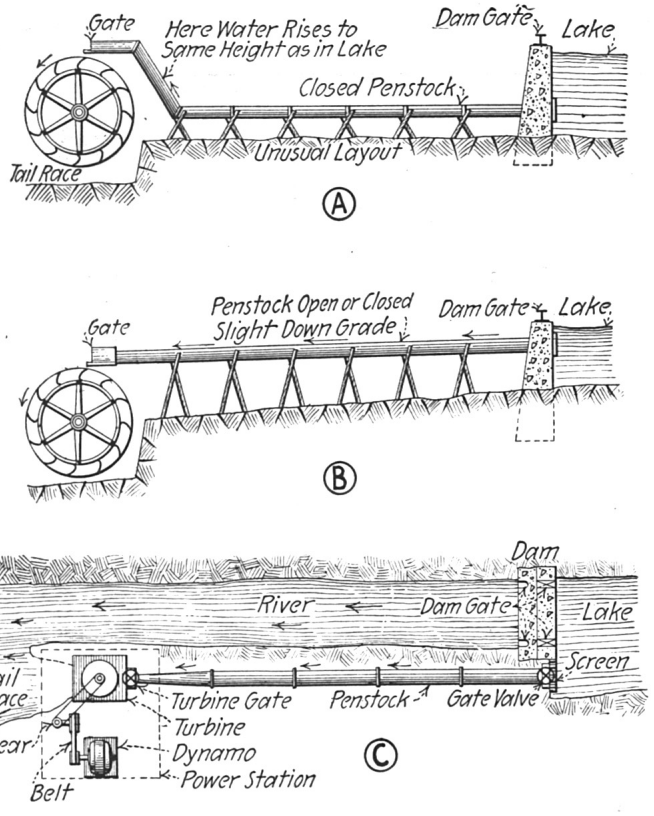


FIGURE 2

Fig. 2. This Illustration Shows Several Modern Features of Small Water Power Plants Which Should Be Studied Carefully Wherever Water Power Is to Be Supplied. Various Arrangements of Overshot Water Wheels as Well as Small Turbines Are Shown at Figs. A, B, C and D. Water Power Is One of our Greatest Natural Resources and One Which We Constantly Ignore, Preferring to Buy Coal or Gasoline for Driving Engines, All of Which, of Course, Represents an Unpardonable Waste of Natural Power. Brazil Has Developed Its Natural Water Power More Than Any Other Country.

ing of a round stick, weighted at its base so as to just clear stones, etc., at the bottom of the stream, and we time this float as it is carried down-stream from one fixt point to a second fixt point, then its speed and also that of the current of water is readily deduced. A common figure for streams is 6 to 15 second feet, meaning that the float when timed traversed a distance of 6 feet in one second. Several time values should be observed at various times of the season and an average of the lot taken. Sometimes the minimum value determined is taken. The current velocity having thus been found, the volume of water passing per second in cubic feet is found by multiplying its value by the average width and depth of the stream in feet at the section timed.

The quantity of water is generally measured on small streams by means of the "Wier," which is explained together with formulas for its use in any text-book on the subject.

The plant layout is shown at Fig. 2. An overflow gate is best placed on the dam, but some builders arrange for the water to spill over the dam only when the lake is full. The dam can be made of concrete, stone or stone and earth, wood, etc., as convenience dictates. The penstock feeding the turbine or water-wheel enters the stream as shown, preferably placing a gate at the head of it and a screen of iron bars in a wood or metal frame to prevent sticks, stones, etc., from entering the penstock is placed ahead of the gate as shown. The penstock is depicted at Fig. 3-A and B in detail. It can be either open or closed. The open ones are commonly made of white pine tongue and grooved planking, concrete, steel, etc., and the closed ones are usually of steel pipe or wooden staved pipe, strengthened with iron hoops around it. Of course, the penstock must have a pitch downward toward the turbine, and it is carried sufficiently far down-stream, so that the pressure head obtained at the turbine wheel is sufficient to drive it at the required speed and torque. The head in feet is the "vertical height" the water drops thru in descending from the entrance to the penstock to the turbine wheel. For small plants it is well to figure the penstock to carry about twice the cubic feet of water per minute required by the turbine as the penstock probably will not always flow entirely full.

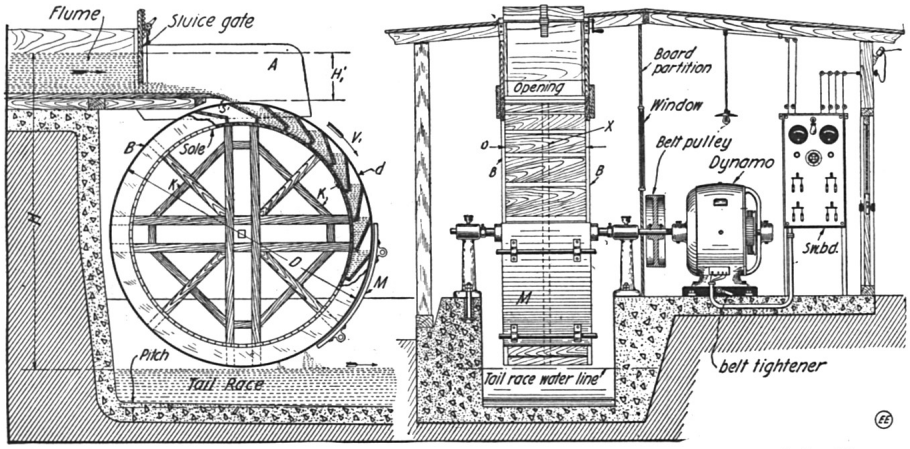
It is very important that the tail-race or passageway provided for carrying away the discharged water from turbines and water-wheels be made sufficiently large so that the water can readily pass away without causing "back pressure" on the turbine. The discharge pipe if provided should be as large at least as the discharge opening in the motor. No great pressure is present here, so a sheet iron pipe is sufficient for small motors.

The theoretical or full horsepower of a given stream is calculated as follows: First, having found the amount of velocity in feet per minute of the water which is equivalent approximately to 75 per cent of the observed velocity by means of floats, owing to the fact that the water near the edges and deeper down in the stream does not move as fast as that of the main channel, we multiply this value by the cross-section in square feet which gives us the number of cubic feet available in the stream per minute. We next multiply the number of cubic feet per minute by 62.3 pounds (the weight for a cubic foot of water) times the head or drop in feet and then divide this by 33,000.

EXAMPLE OF STREAM H.P. DETERMINATION.

Let us take an example: suppose we have a stream two feet deep by five feet wide and that the average mean velocity observed by watching floats dropt into the water and passing over a measured distance between two stakes is three feet per second or 180 feet per minute. Then, following the rule just given, we multiply 1,800, the number of cubic feet per minute times 62.3 times the head which, let us say, is 10 feet. Dividing the total product of these terms by 33,000, we obtain 33.9 or nearly 34 horsepower. The average efficiency of a water-wheel is about 75 per cent and hence the actual horsepower which we may realize from such a stream, giving us a steady flow of water under the above depth, width and velocity dimensions—then 75 per cent of 33.9 h.p. gives us 27.2 net horsepower. Referring to tables giving the horsepower of standard makes of water turbines, we find that to develop this horsepower it would be required to use a 27-inch diameter special steel turbine wheel of the Jonval type. This wheel would, under a 10-foot head, at 220 revolutions per minute, consume 1,854 cubic feet of water per minute and deliver 26.34 h.p. at the shaft. This size turbine will use 172 square inches of water at the intake. If a water-wheel, either home-made or of the regular commercial type, constructed of steel or wood is to be employed, then we will have to figure out in accordance with some of the rules and simple formulæ given in the previous article referred to above how to determine the

(*Continued on page* 312)

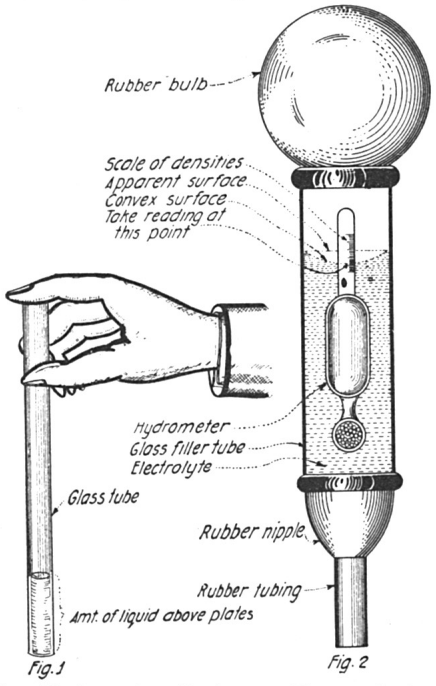


Side and Front Views of a Typical Overshot Water Wheel Which Can Be of the Home-Made Type. It Is Shown Driving an Electric Lighting Generator. It Is Best, However, to Drive the Dynamo with a Belt and Connect It Indirectly to the Water Wheel Unless a Very Steady Supply of Water Is Available for Driving the Wheel; Otherwise, There Would Likely Be Too Great a Fluctuation in the Voltage, Which of Course Would Be Noticeable at the Lamps. The Next Installment Will Illustrate and Describe a Very Excellent Arrangement for Dynamo Drives, Together With an Automatic Speed Regulator To Be Connected to the Sluice Gate.

Care of Lead Plate Storage Battery

By JESSE J. HIPPLE
CHIEF MACHINISTS' MATE, U. S. N.

MOST of the small storage batteries are constructed to give a heavy initial output required for auto starters, auto ignition, etc. This type of battery is usually of the 1300° *Specific Gravity* class. In other words, the specific gravity of the electrolyte should be over 1300° when the battery is fully charged. The cells composing a battery of this type are very compact and there is very little room for electrolyte. It is on account of this lack of space that the gravity of the electrolyte is higher than the larger type of battery called the 1200° battery. In the 1300° type, the voltages run anywhere from 4 to 12 volts per battery, depending, of course, upon the number of cells. In the 1200° class the voltage varies according to the use that the batteries may be put to, but where they are intended to be easily handled, each cell is separated. In both types of battery the voltage for a single cell immediately after full charge is from 2.3 to 2.2. After a short time this value drops to about 2 volts. The amperage of the 1300° battery ranges from 40 to 80 amps, while that of the 1200° battery may be anywhere from 100 amps per hour up, depending upon the size and quantities of the plates. The principal use of the 1200° battery is for electric lighting outfits and in all places where long usage before recharging is of more importance than portability.



The Hydrometer Syringe. Figure 2, Is a Handy and in Fact Indispensable Device for Testing the Specific Gravity of Battery Electrolyte. It is Particularly Useful for Ignition Batteries.

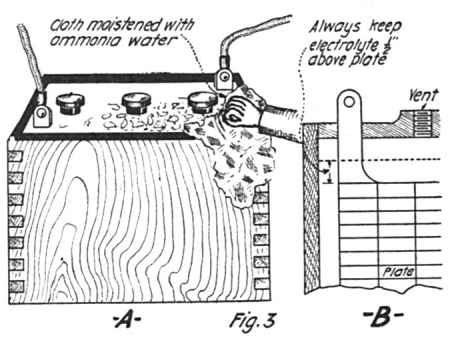
Fundamentally both types of batteries are the same as far as the component parts are concerned. Of course the 1300° battery is much lighter than the 1200° battery and is therefore more desirable for *radio work,* requiring a battery that is easily carried.

This article will deal then with the care of the 1300° battery, but all that will be said in connection with it may be applied to the 1200° battery with the exception of the hydrometer readings. For the 1200° battery the hydrometer readings should be 100° lower than those for the 1300°.

The first rule to be carefully observed is *Cleanliness.* The battery should be at all times free from acid on the top. When acid is accidentally spilled, it should be carefully removed by wiping with a cloth that has previously been moistened with a solution of ammonia water. See Fig. 3-A. Keep the top of the battery clear from dust or metal filings. The vents in the filler caps should be kept free and clear to allow the generated gases to pass off freely. All outside metal parts such as lugs, terminals, connectors, handles, etc., should be lightly coated with vaseline or grease. If a cover is provided for the battery, it should be kept in place except when charging. When charging, the covers and the filler plugs should be removed.

It is very important that the level of the electrolyte in the battery should be at all times at least ½ inch above the top of the plates, as shown in Fig. 3-B. To make this observation the writer has made use of a piece of glass tubing about 8 inches long (Fig. 1). This tube was inserted in the filler hole and allowed to touch the tops of the plates perpendicularly. The index finger of the hand holding the tube was clampt over the top opening and the tube withdrawn. The amount of liquid in the tube represented approximately the height of the surface of the electrolyte above the plates. It might be well to say that in very few places is tap water of sufficient purity to be used in storage battery work and in most cases it would prove disastrous to the battery. Under no circumstance allow sea water or any water strongly impregnated with chlorin salts or metallic salts to come in contact with the interior of the battery. Electrolysis of solutions of chlorin salts liberates nacent chlorin, which is a deadly and highly corrosive agent. Metallic salts tend to form an internal short-circuit and change the character of the plates. For those interested in the chemical change when sea water is decomposed, the following reaction is given.

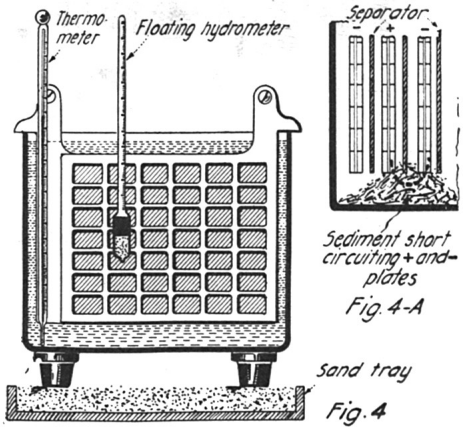
$$2\ NaCl + H_2SO_4 = 2\ Cl. + Na_2SO_4 + 2H$$



Wipe Off Storage Cells With Cloth Dampened in Ammonia Water to Obliterate Acid and Dirt, Which Often Causes Short-Circuits and "Leaks".

To be absolutely safe, use only distilled or rain water.

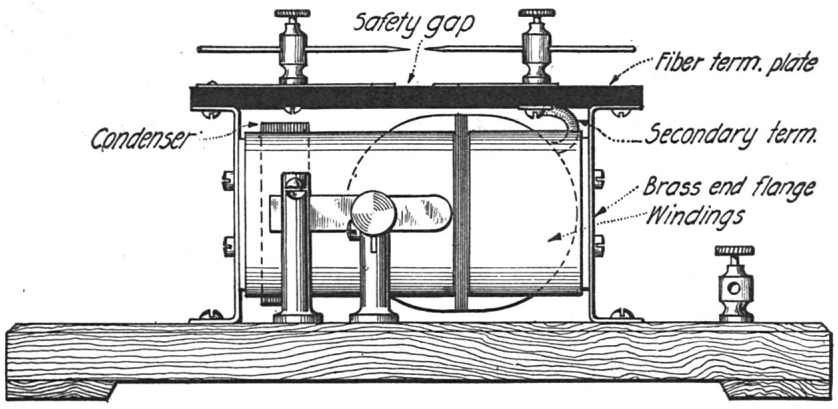
After a battery has been fully charged, the specific gravity should be around 1350°. This will drop to about 1300° after the first few minutes of use. These readings are made with a hydrometer, usually one of special construction for just this kind of work. (Fig. 2.) As the energy of the battery is withdrawn, the specific gravity gets lower and lower until it registers about 1250°. It is then time to re-charge, for the drop from this point is very fast and the battery tends to sulphate heavily when discharged past 1250°. Never add acid to a battery to try to bring up its gravity. Bear in mind that very little of the acid evaporates, and if it is ever necessary to replace any of the electrolyte by reason of spilling or some other cause than evaporation, the electrolyte used to replace that lost should be mixed to the same gravity as the cell it is intended for. Roughly, the proportion should be four parts water to one part acid. Only use chemically pure sulfuric acid for batteries. **When mixing acid with water, the acid should be added drop by drop to the water and the water should be constantly stirred! If the water should be added to the acid a dangerous explosion would occur and the least of the damage would be acid splattered clothing and hands, not to speak of burned face and eyes!** Always use a glass or porcelain vessel to mix electrolyte, and as the mixture of sulfuric acid and water generates heat, the temperature should be watched so that the vessel does not crack. Never take electrolyte from one battery to add to another. Mix fresh if necessary.



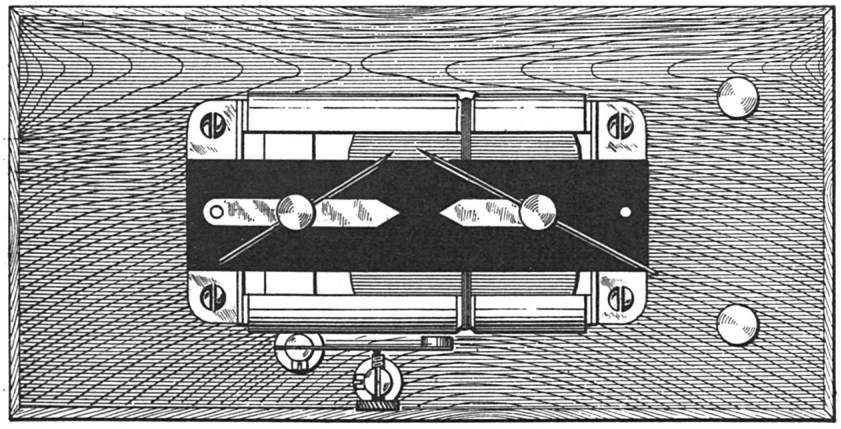
The Use of the Thermometer and Floating Hydrometer is Clearly Shown Here. Also How Sediment Collections May Short-Circuit Plates.

When taking a hydrometer reading, the following procedure should be observed. The filling tube should be rinsed out with distilled water and then sufficient electrolyte should be sucked up from the filler hole in the battery to float the hydrometer. (Fig. 2.) The reading of the gravity

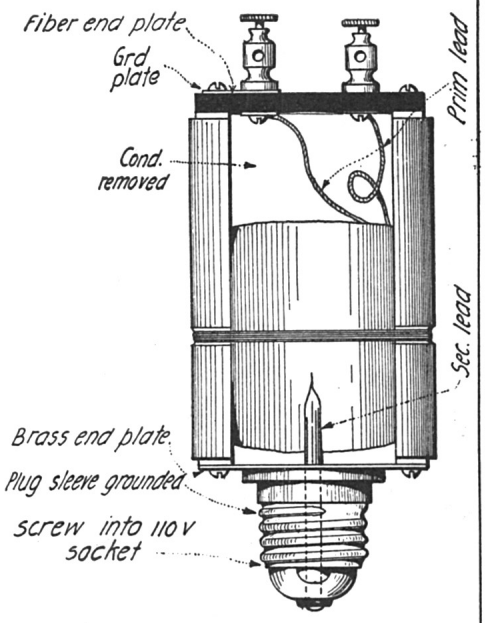
(*Continued on page 322*)

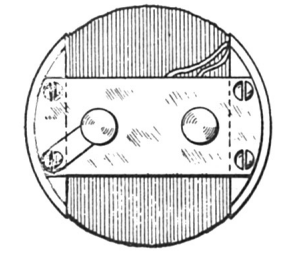


Wiring not shown for sake of clearness same as any induction coil except one end secondary grounded on core.



Magneto Armature Made Into Induction Coil (D.C)





Magneto Armature Utilized as Low Voltage A.C. Transformer

EE

The Drawings Herewith Show Two Practical Uses for Old Magneto Armatures, Especially Those of the "High Tension" Type, Which the Electrical Experimenter Will Find Interesting. One Idea Shows How to Make an Induction Coil and the Other, a Step-Down A.C. Transformer for Running Bells, Lighting Miniature Night Lamps, Etc.

Utilizing An Old Magneto Armature

By H. H. PARKER

AN armature taken from an old "junk" magneto, provided its windings and condenser are in good shape, may be converted into a first rate small induction coil for experimental purposes. The illustration suggests an arrangement, though the exact details would depend upon the make of the magneto from which the armature was taken. Both heads with their stub shafts and gears are removed; then two stationary heads are cut out of heavy sheet brass and screwed to the armature, using the same bolts or screws that fastened the regular heads. The lower ends of the sheets are bent over and drilled for screws to attach the coil to a baseboard, while the upper ends are bent over to form attaching lugs for the fiber block which holds the high tension binding posts. The most compact condenser arrangement is where the armature contains a space for it at one end, as shown; if the condenser is separate, it may be set into the bottom of the wood base.

A vibrator will be necessary; a separate one may be used, though a fairly efficient one can be made as shown. The vibrator head is set near the center of the coil and nearly touching the outside of the armature core. Such a vibrator works in exactly the same manner as on a regular induction coil. For the sake of clearness no connections are shown, but they will be the same as the conventional coil connections, tho it should be remembered that both primary and secondary coils are grounded on the core.

A safety gap to protect the secondary winding will be just as necessary as on the magneto and one is shown constructed of two brass strips incorporated into the secondary terminals; one is extended to meet the brass screw from the end plate in order to form the ground connection for the secondary terminal as well as for the gap. The gap should be made of the same length as the one on the magneto. The other secondary terminal must be far enough away from the core, screws and other metal parts to preclude the possibility of a spark jumping across. The core can be either left open, as shown, or surrounded by a fiber tube.

About six volts will operate the coil; dry cells or a storage battery.

LOW VOLTAGE TRANSFORMER FROM ARMATURE.

Another use to which a magneto armature may be put is a *low voltage transformer* operated off a 110 volt house lighting circuit. The sketch shows a sheet brass disc screwed to one end of the armature and a screw base, taken either from a burned out bulb or an attachment plug, soldered to it. The insulated secondary terminal is carried down and attached to the center terminal of the screw base. A corresponding fiber disc is screwed to the other end to take the low voltage binding posts; one of them is grounded on the core by a strip of brass. The regular *secondary* coil now becomes the transformer primary, while the magneto *primary*, or coarse wire coil, becomes the transformer low voltage, or secondary, coil. The low voltage obtained will depend upon the amount of wire on the armature, and this differs with different makes of magneto, but enough current should be obtained to ring a bell or light a three-volt flashlight bulb; if not enough current is produced, some more wire, say No. 25 B & S, preferably enameled may be wound around the outside of the coil and connected in series with the primary, that is, the coarse wire, coil of the armature; no attempt should be made to change the fine wire winding. In most cases the fine wire coil will carry 110 volts without overheating.

A 110-Volt Electric Toaster

By JOHN C. DAVIS, Jr.

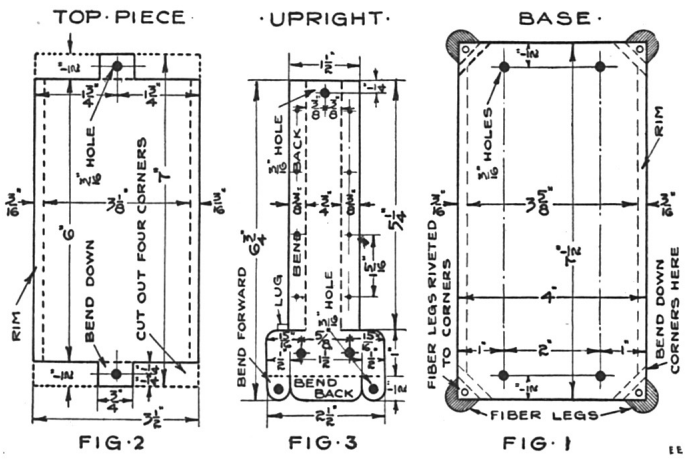


FIG. 2 FIG. 3 FIG. 1

Detailed Views of Home Made 110 Volt A.C. Or D.C. Electric Toaster. One Thing to Remember In Building Any Electric Apparatus, Especially Anything Which Generates Heat, Such As This Device, and Intended for Use On 110 Volt Lighting Current Is That It Should Be Constructed In As Fireproof a Manner As Possible. In Any Case, the Apparatus Should Set Clear of the Table Or Other Furniture On Which It May Rest. Another Very Important Idea Is to Place a Wire Guard Around All Heating Coils.

THE frame of the toaster is made of No. 24 galvanized sheet iron. For the base cut a piece 7½" x 4" and bend down the corners. Draw a line across each end, parallel to and ½" from each end. On each line, 1" from the ends of the line, bore two 3/16" holes. Next bend down a 3/16" rim on each edge, to strengthen it, making the width 3⅝". The legs are semicircles of heavy fiber, ½" in radius, riveted to the inside of the corners. (See Fig. 1.)

The top must be 7" x 3½". Cut down the ends until it is 6" long, leaving tabs in the middle of each end ½" long and ¾" wide. Bore a 3/16" hole in the center of each tab and bend down. Round off the corners of the top, and, for stiffness, bend down a 3/16" rim, as with the base, making the actual size of the top 6" x 3⅛" (see Fig. 2). Cut a piece of No. 26 sheet copper just small enough to fit under the top-piece between its edges. This will tend to throw the heat downward and outward, which otherwise would rise directly up.

For the two uprights cut out a piece of the iron 6¾" x 2½". The bottom part of the upright is 2½" wide by 1" high with tabs ½" long folded over the bolt to the base. The upper part of the upright, 5¼" long, is cut down to 1½" wide. The edges of this part are then bent in so that they nearly meet, forming a slot for the mica units to rest in and making the outside width of the upper part of the upright ¾". Bore a 3/16" hole near the top of each upright. These are for bolting onto the top-piece by means of the tabs on the same. (See Fig. 3.)

The element may be made up of the proper length of "Nichrome," "Climax," "Advance," or any other good resistance wire having a high melting point and a comparatively high resistance.* I used 12 feet of No. 28 "Nisil" wire. It draws about 5 amperes on 110 volts. The wire is wound on three strips of extra heavy mica, 5⅞" x 1¼". It is best to use three or four pieces of mica as it will be apt to burn right thru where a red-hot wire touches it. Slots are cut in the edges of the mica ⅛" deep, making the turns of wire 1" long. When assembling the toaster the three mica strips (connected in series) should be placed, one above the other, in the slots formed by the edges of the uprights. As there is altogether 12 ft. of wire, 4 ft., or twenty-four 1" turns must be put on each of the mica strips. However, if the wire were spread evenly all over the toasting space (4½" x 5½"), the result would be very uneven toasting. Owing to the tendency of the heated air to rise the bread would toast much sooner at the top of the slice than at the bottom. To counteract this the wire should be wound as follows: Bottom unit, 28 turns; middle unit, 24 turns; top unit, 20 turns. When half of each strip has been wound the winding should be reversed and the remainder of the unit wound in the opposite direction, as a continuous winding would be apt to induce a strong magnetic flux which would decrease the efficiency of the element, especially on A.C. circuits. The ends of the wires should be brought down to one corner of the toasting space and there terminate in copper lugs, which are clamped under the nuts on the back of the lead pegs. (See Fig. 4.)

For the lead pegs cut two pieces 3/16" brass rod 1" long. For a distance of ¼" from one end file or turn them down to ⅛" in diameter. Next procure four ⅛" rather thin brass washers, the outside diameter of which must be ⅜". The small ends of the rods must then be threaded. Halfway (½") up in the base, or wide part, of one of the uprights, bore two ¼" holes, each 15/16" from one edge, making them ⅝" apart. In assembling the pegs onto the frame use three or four thicknesses of mica washers as insulation from the frame. (See Fig. 5.)

Before assembling the uprights bore four 1/16" holes equally spaced in the inside edges of each upright. These are to support the grids or wire guards which prevent the bread from coming in contact with the naked heating element. The grids are composed of four horizontal pieces of No. 16 or 18 (B. & S.) brass wire, connected in the middle by one vertical piece. They should be placed as near as possible to the heating element without danger of actual contact with the same (not farther than ⅜"). It will be found easier to spring the grids into place after the rest of the toaster is assembled, as otherwise they would be apt to interfere with the proper placing of the units. (See Fig. 6.)

As for the holders for the bread they are so many and so varied that perhaps it would be best to let the constructor choose his own. The simplest method is to build the grids at a slight angle, with a rest at the bottom, so that a slice of bread will lean against them. Or a holder may be made similar to the majority of standard makes of toasters, hinged at the bottom and provided with a stiff spring to hold the bread against the grids. With a little ingenuity a holder of the "Turn-over" or "Flip-Flop" type could easily be constructed.

If trouble is experienced due to the warping of the mica units when heated it can be obviated by fastening short pieces of stiff wire at various points on the grids so that one end will touch the mica between the turns and prevent it from bending.

The appearance of the toaster would be greatly improved, for table use especially, if it could be given a coat of nickel-plate. The parts must be nickel-plated before assembling if this is to be done.

The Home Electrician, after a little experimenting with the construction of electrical apparatus of this nature, will find it an easy matter to construct electric heating units or else purchase them and build into regular type percolators, chafing dishes, tea pots, curling irons, etc.

It should be remembered that resistance coils made from ordinary wire will not prove satisfactory as such wire, after a few heating and cooling applications, will heavily oxidize. This is the case when copper, iron or even German silver wire is used for constructing heating units where a high degree of temperature, say 200 to 400 degrees Fahr., above room temperature, is desired.

There are from fifteen to twenty different classes of special resistance wire available on the market for constructing resistances, heating units, etc., from, and at least several which are markedly efficacious for the purpose. One of the best is Nichrome wire, but it is practically impossible to obtain it under any ordinary conditions, as it is only supplied to licensed manufacturers who build apparatus containing this patented material. A very excellent resistance wire which possesses practically identical properties to Nichrome is *Calido*. It has a resistance of about 58.5 times that of copper wire, size for size.

* Note.—On receipt of a stamp the editor will be glad to furnish addresses of several manufacturers of resistance alloys suitable for use on heating apparatus.

This illustration Shows the Assembly View of the Toaster and the Three Heating Elements. The Heating Units Are Composed of Three Strips of Mica Having a Fine Resistance Wire Wound Around Them In Suitably Spaced Notches Or Slits In the Manner Shown. The Three Resistance Units Are Connected In Series and Finally Joined to the Mica Insulated Terminal Posts Shown At Fig. 5.

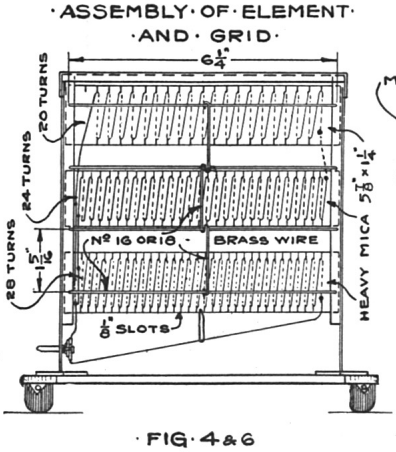


FIG. 4 & 6

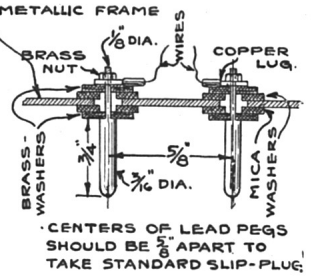


FIG. 5

An Efficient Primary Battery

By W. S. STANDIFORD

THERE are two types of electric batteries used by experimenters, viz., open and closed circuit cells. The former are used for ringing door bells and other intermittent work, while the closed circuit cells are used for charging storage batteries,

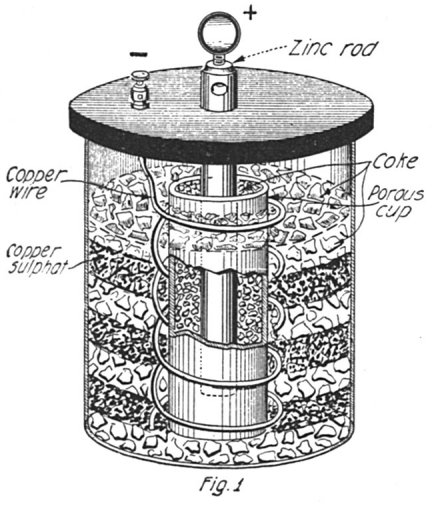


Fig. 1

The Author Describes Some Interesting Results Of His Experiments With a Modified Form of Daniell Cell, Which He Has Found Suitable for Use On Both "Open" and "Closed" Circuit Work — the Great Battery Goal of All Experimenters! The Parts Necessary for Making This Battery Can Be Obtained At a Nominal Cost from Any Electrical Supply House or Dealer.

running small electric motors, Christmas tree lights, electro-plating and general experimental work where a continuous current is desired. As a general rule closed circuit batteries don't work well on open circuit, and they cannot be put away without using, on a shelf for a month or so, unless the binding posts are connected with resistance wire so as to allow a very small current to flow; this keeps the battery in order—but also wastes chemicals and the zinc electrode.

What the amateur electrician desires, most of all, is a battery that will give either a constant current when it is wanted, or one that can be used on an open circuit, such as ringing door bells, etc., and one that can be laid away until wanted for use. The usual type of Daniell Sulphate of Copper battery in both the ordinary and gravity forms, gives a continuous current until the chemicals are exhausted, it being an admirable battery where a steady current of long duration is desired; the drawback being that they cannot be used for open circuit work as copper is deposited upon the zinc, causing the latter to be eaten away rapidly when the cell is not in use. The writer has found out after some experimenting that by making a few modifications in the original design of the Daniell cell, it can be used eitlfer for closed or open-circuit work; it always being ready for use when wanted. Procure from an electrical supply house a glass jar and porous cup of the size wanted, one nickel-plated binding post, a zinc rod containing a binding post on the top, such as is used on the ordinary sal-ammoniac open-circuit battery, 6 feet of No. 14 insulated copper wire, 2 lbs. paraffin wax, a small round brush, and also some coke and 3 lbs. sulfate of copper. Melt the wax in a saucepan, being careful that it doesn't get on fire, then dip the bottom of the porous cup into the wax, letting it extend ½ inch up the side. Do the same with the open end of the cup. Also dip or paint the top of the glass jar for a distance of 2 inches. The object of the wax coating is to prevent the chemicals from creeping up the sides and over the top of the jar and also porous cup, the bottom of the latter being insulated by the wax. Make a cover out of a ¾-inch board, the cover to have a rabbet or cleats nailed on its under side so as to prevent its sliding sideways; a round hole for the zinc electrode should be bored in the center.

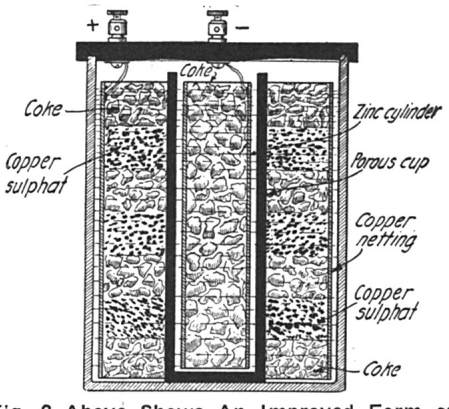


Fig. 2 Above Shows An Improved Form of the Battery Delineated at Fig. 1 by Mr. Standiford; This Suggested Form of the Battery Being the Editor's Idea. Instead of the Copper Wire Electrode Used At Fig. 1, a Piece of Copper Netting Is Here Used.

After completion, boil the cover in the hot wax for 30 minutes, drain and let it cool. After it is cold, take your brush and put an extra amount of wax on the inside of the hole for insulation, or, if desired, a porcelain tube of sufficient diameter to hold the zinc electrode can be used as an insulator. Stand the cup in the center of jar. Break the coke into pieces the size of coffee grains and put a layer on the bottom of the jar surrounding the porous cup. Screw

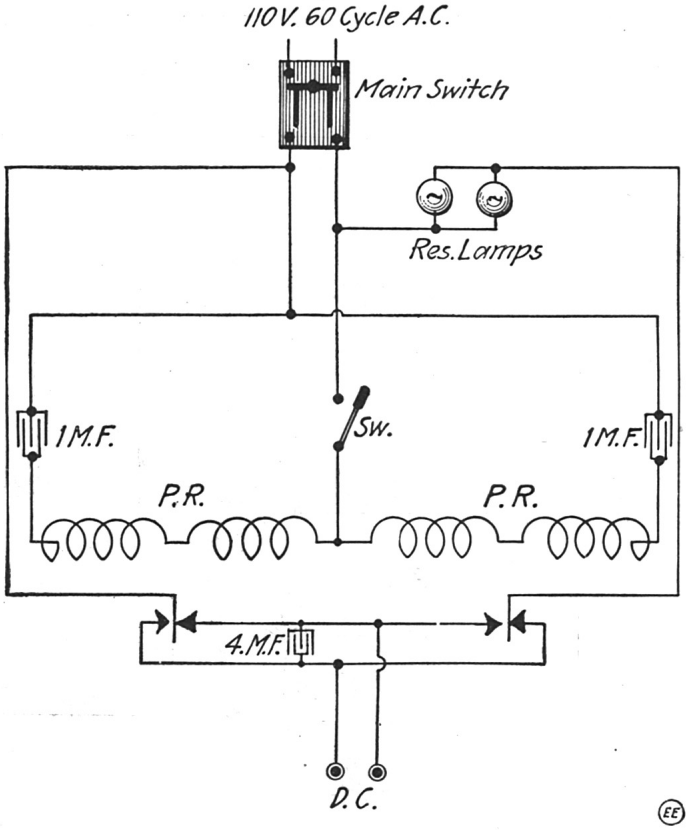
(*Continued on page* 324)

How to Build a Mechanical Rectifier

Herewith is given a sketch of a mechanical rectifier which may be of interest to "E. E." readers. In making some electrical tests it was necessary for me to have direct current of about 50 volts and the only current available being 110 volts 60 cycle, A. C., it was necessary to construct some type of rectifier. Two of the old style, double-contact polarized relays were used, each having a 1 M.F. condenser connected in series with the coils, as this was the only way they would operate satisfactorily without sparking at the contacts. The relays being of the double-contact type, opposite contacts were connected together, which rectified both waves of the A.C., which was necessary on account of using the current to operate relays and other direct current apparatus. When used for this purpose the D.C. leads are connected thru impedance coils which are not shown in the diagram. Lamps were connected in the A.C. side to regulate the current. A 4 M.F. condenser is connected across the D.C. leads.

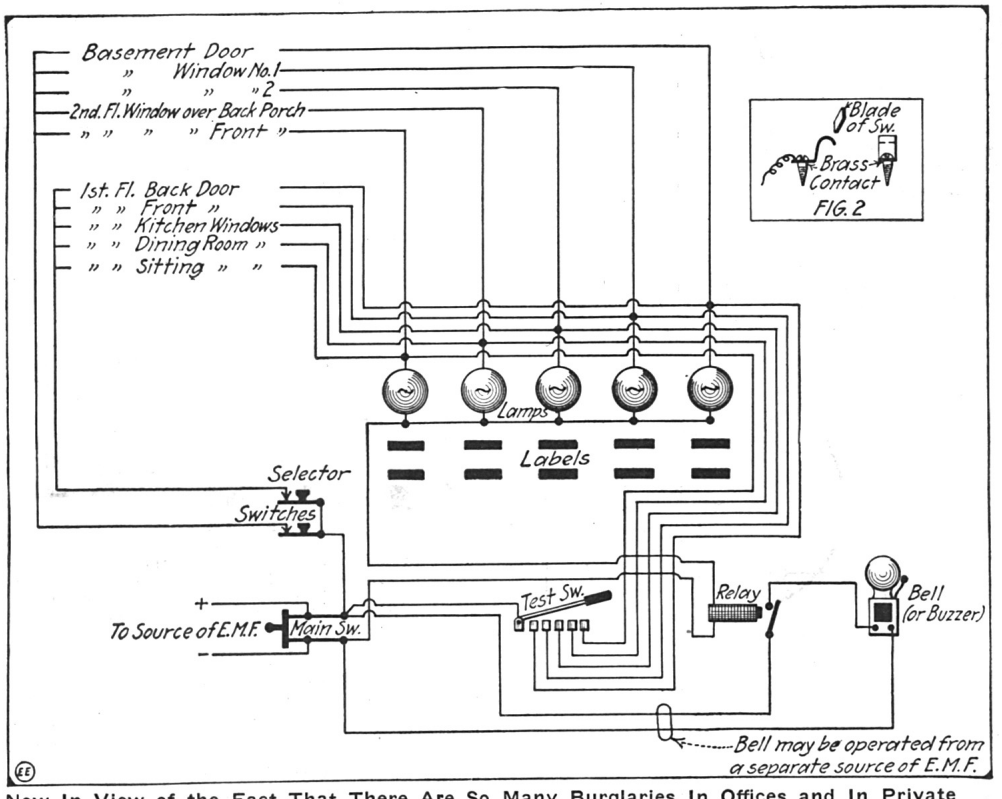
There Are Rectifiers and Rectifiers, But Perhaps One of the Easiest to Construct Is That Here Suggested by Mr. Weaver, and for Building Which He Gives Full Details in the Accompanying Article. As Mr. Weaver Says, "In Making Some Electric Tests It Was Necessary for Me to Have a Direct Current of About 50 Volts and All That Was Available Was a 110 Volt 60 Cycle A.C. It Was Therefore Necessary To Construct Some Type of Rectifier and I Employed Successfully Two Double-contact Polarized Relays, Each Having a 1 Microfarad Condenser Connected in Series With the Coils.

"This Was Found to Be the Best Way to Operate Them Satisfactorily, Without Sparking On the Contacts. The Relays Being of the Double-contact Type, Opposite Contacts Were Connected Together Which Thus Rectified Both Waves of the Alternating Current." The Resistance Lamps Used Can Be of the 110 Volt Type; the Higher the Candle-power of These Lamps, the Greater the Current That Will Flow Thru the Circuit.



Contributed by
ROBERT M. WEAVER.

Electric Burglar Alarm



Now In View of the Fact That There Are So Many Burglaries In Offices and In Private Homes, Electric Burglar Alarms Have Come Rapidly Into Favor. The One Shown Here Possesses the Distinct Advantage of Requiring But Very Simple Apparatus and Also the Wiring for the System Has Been Reduced to a Minimum, Considering the Fine Results Obtained.

In making this burglar alarm I used 48 ohm telephone switchboard lamps and a small telephone relay, but any kind of lamps may be used, provided you have a relay that will work in series with them and use the proper voltage. The best kind of relay to use is one that must be reset by hand, then if the burglar opens a window and shuts it again the alarm will continue to ring until the relay is reset. The test switch is made by taking the blade of a small single pole switch and mounting it on a base with five contacts made of thin brass strips (like the detail drawing, Fig. 2) in such a way that when the switch is closed it will make good contact with each of the five brass strips. It is best to use a bell or buzzer of the same voltage that the rest of the system works on, but it is not necessary, the bell being connected to a separate circuit, i. e., I have my system working on 50 volts and my bell on 110 volts. My bell is mounted on the outside of the house where it will wake up the neighbors, as well as myself.

In putting the system in operation at night you want to test it well. To do this you should first put in the main switch. If the alarm rings, there is a window or door open somewhere. How to find the exact place will be told below. If the alarm does not ring, the system is "O. K." Next you test out the lamps by throwing in the test switch. If the lamps all light, they are all right. If any of them fail to light, they are burned out. You shouldn't leave the test switch in over a couple of seconds or the current going thru the five lamps in multiple will cut the resistance down enough to damage your relay.

Suppose a burglar tried to enter the basement door. He would close the contact on the door, light the fifth lamp and ring the alarm. Now the fifth lamp serves the "first floor back door" as well as the "basement door." To find out which it is you press down the first selector switch. The lamp will still burn so you know it is not on that circuit. Then you press down the second selector switch which in this case will open the circuit and put the light out. Read across the second row of labels to the the one under the fifth lamp, and it will indicate that it is the "basement door" that is open.

You can readily see that this system can be built up to any size by merely adding a selector switch and a row of labels for each five outlets.

I have my system all mounted on a box measuring but 5" x 6" x 3", so you can readily see it doesn't take up much space. It can be mounted on the wall at the head of the bed or set on a chair.

Contributed by F. P. FOULK.

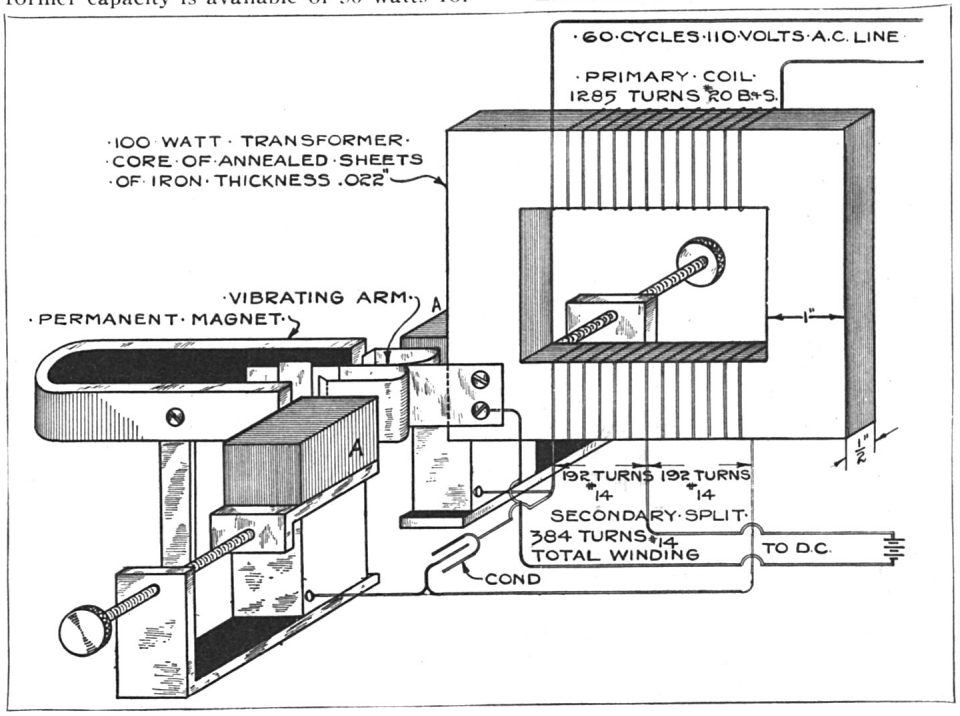
A Synchronous Vibrating Rectifier

In the Present Article the Author Describes How to Build a Synchronous Vibrating Rectifier, Having Carbon Electrodes Which Will Not Burn Out, Due to Arcing. A Rectifier of This Type Will Work Very Satisfactorily, and Is Suitable for Charging a Storage Battery Such As 6 Volt Ignition Units From the 110 Volt A.C. Supply Circuit.

The changing magnetic field set up by an alternating current in a static transformer is carried by a hardened steel spring, such as that in a clock, to the poles of a permanent magnet, causing the spring to vibrate. The changing magnetic polarity of the spring, due to the current in the transformer, makes the spring move from one pole of the permanent magnet to the other. By using this action, current delivered from a secondary coil may be directed in such a way as to give a pulsating direct current. Carbon contacts on the spring touch the carbon blocks A-A. A .1 mf. condenser makes the current flow more regular, and cuts down the arcing.

The dimensions given on the diagram are for a 100-watt transformer, although the core and windings can be designed for as high as 500 watts. Only one-half the transformer capacity is available or 50 watts for the design here described and illustrated.

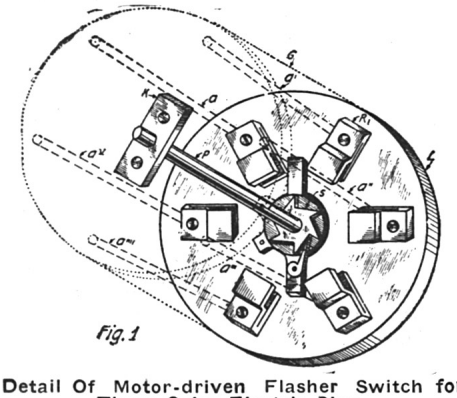
Contributed by an
ELECTRICAL EXPERIMENTER.



Three-Color Electric Sign Control

By EARL BOTTEN

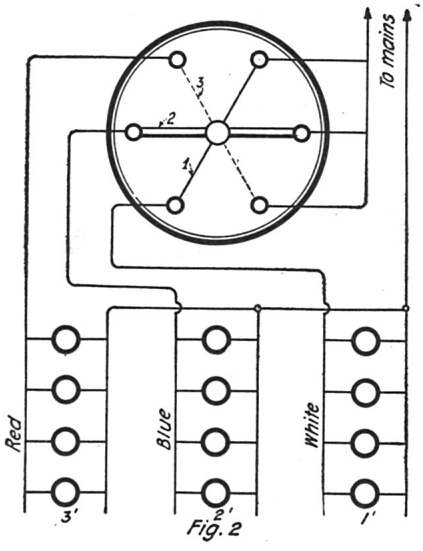
AN electric sign which will flash in different colors is sure to attract a great deal of attention. In this article a control for such a sign is described which



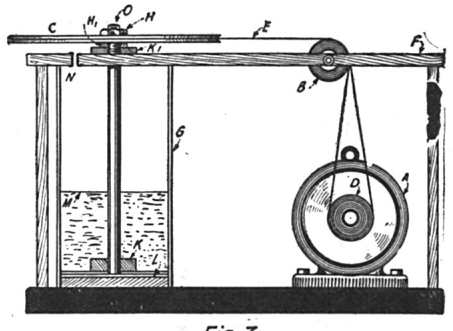
Detail Of Motor-driven Flasher Switch for Three Color Electric Sign.

is easy to make, and as it runs in oil, does away with all danger from short-circuits and sparking. No definite size is given for any of the parts, as they can vary in size according to the material which the maker is able to obtain, without injuring the control in any way.

A large wheel out of an old mantel clock was used. All of the spokes except two opposite each other were cut away, also the stubs of the spokes carrying the spring which holds the ratchet and pawl together were left, as indicated in Fig. 1. Six switch jaws are then set in a circle equal distance apart. They should be set so that the ends of the two spokes will slide easily thru the slots. The base to which these shoulders are fastened should be of hard rubber or fiber, and if bolts are used, the holes on the underside of the base should be deeply counter-sunk, so that the bolt heads will not come in contact with the receptacle (G). Two bearings (K & K¹) should be made of brass or copper, with holes just large enough to admit the shaft (P). The dotted lines (a to a⁵) indicate the wires running from the switch jaws to the lights. The method of connecting the wires to the lights is shown in Fig. 2. After the switch is in place in the receptacle, the receptacle is filled party full of



Circuit Diagram Of Red, White and Blue Lamps Connected to the Flasher Switch, Which Can Be Motor-driven Or Else Operated By a Spring-motor Or By Hand.



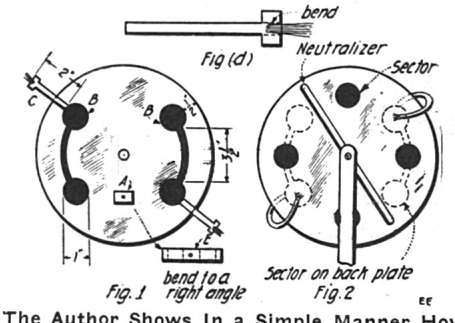
Sectional Side View of Motor-driven Electric Flasher Switch for Colored Lamps On Small Sign Or Decorative Feature, Such As a Tree, Fountain Or Floral Display.

oil, which should be heavy, such as Transil oil. As for running the switch, two methods are given: One shown in Fig. 3 is with a toy motor. A large thin wooden wheel (C) is fastened on the shaft, and held in place by means of the burrs (H H¹). A small pulley (D) is fastened to the shaft of the motor (A) and the belt (E) put on. Idler pulleys (B) are used to direct the belt between the two pulleys. The whole is then placed in a box (F). An air hole (N) should not be omitted. A few dry cells will suffice to run the motor, and the speed can be controlled by means of a small Rheostat. Contributed by "BIX."

Two Novel Suggestions

CHANGING A WIMSHURST MACHINE TO A TOEPLER-HOLTZ.

A Wimshurst machine can be remodeled to a Toepler-Holtz in a short time. I have an E. I. Co.'s static machine and I thought it would be handy to have it arranged so that I could use it as a Toepler-Holtz machine if I wanted to show how this type works. The first thing to do is to procure some plates. On mine I used seven-inch phonograph records. Glass plates can be used but they are difficult to handle. Assuming you have the two plates, drill holes in them large enough so that the bosses will just screw on. Then on one plate paste four round sectors. The sectors can be cut out of the sheet copper



The Author Shows In a Simple Manner How to Change a Wimshurst Static Machine to a Toepler-Holtz Type.

and should be about one inch in diameter. Fasten them on with shellac varnish. They should be put about one-half inch in from the edge of the plate. The next thing is the other plate. Copper sectors are cut as shown in the illustration, Fig. 1. At the projection C is a clamp to fasten tinsel brushes to. The tinsel is fastened on as shown at D the copper can be bent over and used to hold the tinsel. The sectors B are fastened on with shellac. Now drill a hole at A about the size of a battery bolt. The clamp E can be made from heavy copper or brass. It has a hole in it and fits over a battery bolt which can be put in the hole A.

The clamp is to hold the plate stationary as only one plate revolves on this machine. Bend the clamp and then put it over the standard on the machine. Then the movable plate is put in place and the axle is put in. Only one neutralizer will be needed and that one will be put on the movable plate. The projections C are bent so that the tinsel will rub lightly on the sectors of the movable plate. The sectors on the back of the stationary plate should have a piece of paper glued on each one with shellac to keep the electricity from escaping into the air. Now set the neutralizers to the position shown and turn the crank so that the plate will revolve as shown. You will have to turn it a minute before it will generate, but don't get rattled. If then it doesn't work the tinsel probably is not touching the sectors. See that it is and then it ought to work all right.

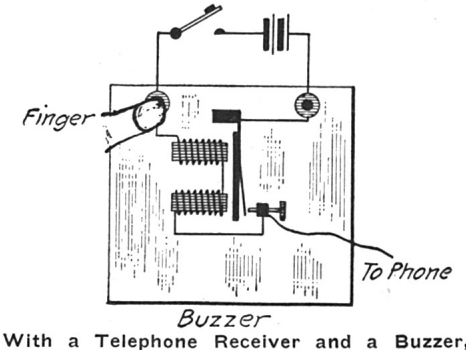
Contributed by CLYDE STEWART.

HEARING THE "JUICE" GO THRU YOU.

With a Tesla coil you can see the high frequency current jumping thru space to your hand—and yet you can't feel anything at all. You have probably "tasted" the current from a dry cell by placing one wire from it under your tongue and the other over it.

But—have you ever "heard" the current go thru you—not seen or felt it—but simply "heard" it? It is very simple. All you need is a buzzer and a thousand ohm (even a good 75 ohm phone will do) phone which all wireless "bugs" have; connect one wire from the phone to the contact pillar and grasp the other wire between the fingers of one hand while you hold one terminal of the buzzer with the other as shown.

Start the buzzer and you will hear the induction current passing thru the phone



With a Telephone Receiver and a Buzzer, Together With a Battery and Switch As Here Shown, You Can Actually "Hear" the Juice Passing Thru Your Body; If You Do Not Believe It, Try It!

via your arms. If three or four people hold hands so that they are all joined up in series you will still be able to "hear the juice" going thru them.

Contributed by K. McLEAN.

Electrical Machinist

By H. WINFIELD SECOR

NO. 9—GEARING AND OTHER DRIVES (Concluded)

THE friction drive shown at Fig. 2 was designed for use in a mechanical testing laboratory where various sizes and forms of automobile speedometers were built and tested. The speedometer, as is well known, at least in *most* types, has a needle, which registers the speed in miles per hour. These are tested in the laboratory by means of a flexible shaft, the same as used when installing the instrument on the car, and at the free end of this shaft, a small friction wheel, usually of fiber, is attacht. The tester then holds the speedometer with one hand, without its casing, and with the other hand he drives a small friction disc supplied to the small flexible shaft to the various speed steps of the multiple special cone pulley shown.

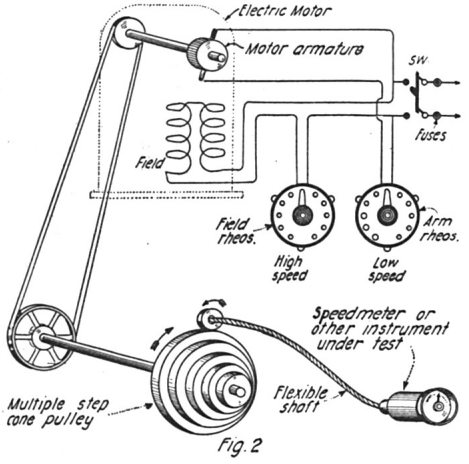


Fig. 2.—Variable Speed Testing Device, in Which Novel Electric Speed Control Features Are Involved.

This cone pulley was designed and calculated so that each step corresponded to a certain unit speed in miles per hour when used with a disc of certain diameter at the end of the shaft connecting to the speedometer.

A "check" speedometer was mounted on the table and rigidly secured to the rotating shaft driving the cone pulley, so that the speed of this shaft could be checked constantly, as the tester stood before it, by just glancing at the speedometer.

To enable the tester to correct the speed of the cone pulley and its shaft which were driven by an electric motor of the shunt type, as shown in the diagram at Fig. 2, two electric speed regulators were mounted on front of the testing table. One of these regulators lowered the speed, while the other raised the speed. The manner in which these were operated is this: To reduce the speed, the low-speed regulator comprised a circular rheostat wound with heavy resistance ribbon, so as to carry the current supplied to the armature of the motor, the motor having been rated at ¼ H.P., 110 volts, D.C. To raise the speed of the motor, the high-speed regulator comprises a field rheostat having small size ribbon windings which were suited to the low current passing thru the shunted field winding of the motor.

Thus, if the speed of the cone wheel ran low, the field rheostat or high-speed regulator was adjusted to increase the resistance in the field circuit, and thus weaken the field which sped up the motor proportionately, to the number of steps on the rheostat, including those in the circuit. If the speed of the cone wheel ran high, and had to be reduced, then the low-speed regulator was turned so as to increase the resistance in the armature circuit, which reduced the current supplied the armature and thus lower the speed of the motor. When the installation was first made, the belt driving from the motor to the cone shaft pulley was computed when the motor was operated on its rated speed in R.P.M. as stampt on the name plate, for the line voltage which it was wound for.

This arrangement thus enables the tester to compensate for any fluctuations in the line voltage which are bound to occur in most all instances.

CHAIN AND OTHER DRIVES.

Chain drives are used extensively in motor installations, even for fairly high speeds and large horse-power. Fig. 3 shows a typical chain drive. The motor in this case is mounted on the ceiling and drives a line shaft by means of a chain of a well-known make.

As will be evident, the chain drive has the advantage that the speed ratios are absolutely positive, and it is often more efficient and especially more noiseless than a directly coupled gear drive, particularly where high speeds are involved, of say, 1,000 R.P.M. and more.

Machine design books contain some data on the horse-power and size of the chain drives, but it is best to procure catalogs and data on these drives from the manufacturers of chain belts, several of which are building them regularly. Two well-known chain drives which are advertised in leading mechanical journals are the Morse and the Link-Belt.

To compute the relative speeds of two shafts such as motor and line shafts, as illustrated in Fig. 3, for a chain drive, the number of teeth on the two gears are figured in the same way as previously explained. The chain then performs the magic function of linking the two gears together, tooth for tooth.

Thus a ten to one ratio between the line shaft and the motor would mean 100 teeth on the gear wheel on the shaft and 10 teeth on the motor gear. The line shaft would then run at 1/10th the speed of the motor shaft. This is only cited for an example, and in practise the motor, if of medium size, would run somewhere in the neighborhood of 1,000 R.P.M., while the shaft would probably be operated at no more than 200 to 300 R.P.M.

Small motors such as 5 H.P. and the like have a speed of 1,750 R.P.M. very frequently, and for a line shaft of average speed, say 250 R.P.M., the speed ratio is one to seven; for a belt drive, the diameter of a shaft pulley should be seven times the diameter of the motor pulley, and for gear or chain drives the number of teeth on the large gear mounted on the shaft should be seven times the number of teeth on the pinion on the motor shaft.

It should be mentioned that one of the excellent features developt in the modern chain drive is the fact that the chain links have been so well developt in every fundamental, that they move along with their changing angle without any lost motion between the gear teeth, causing them to faithfully follow the contour of the teeth and thus they attain their pitch at two or more points with a certain heavy strain on the pulley and act in fact like a flexible gear or rack.

Chain drives should be well lubricated and a heavy lubricant for special drive pitches are available on the market, which should be applied to them frequently by the maintenance men.

For leather belt drives, there are several excellent dressings available on the market, which can be applied to the side facing the pulleys, and one of the old well-known dressings is "Neatsfoot Oil". A leather belt should not be overdressed, as this is just as bad as no dressing at all.

In emergency, molasses has been applied to belts if it slipt excessively, and also pulverized or crushed resin; but one of the iron-bound rules of the machinist is not to apply resin to ANY belt. The effect of the resin, as experience will show, disappears in a very short time, even in half an hour, and it leaves the surface of the belt in a bad condition, filled with hard, gummy lumps of resin, and making a muss of things in general so that some good liquid dressing would have to be applied for some time to get it in good shape again, if in fact, the resin has not burned the belt in spots, owing to its chemical effect. It is

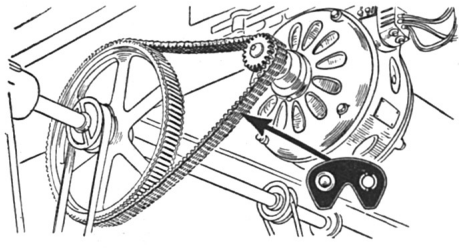


Fig. 3.—Chain Drive from Electric Motor to Line Shaft.

usually recommended in machinists' hand books to place the hair-side or rough side of leather belts against the pulley, but it is doubtful if this is advisable under any circumstances. The writer has seen hundreds of leather belt installations of all widths conceivable, and these were invariably placed with the smooth or dressed side of the belt to the pulley.

One reason why the smooth or dressed side of the belt should be placed to the pulley is this: The horse-power to be transmitted by a belt is tested and computed in machine designs by the number of square inches of belt surface passing over the pulley per minute. It will at once be seen that if the rough side of the belt is placed against the pulley that the friction caused by contact between the belt and pulley will only be one of a series of high spots, and thus when full horse-power is to be transmitted from such a belt or pulley, if designed on the regular basis and allowance for velocity, belt width, and horse-power, that the belt will simply not transmit the proper power without undue slipping. In belt drives, either rubber, leather or canvas, all of which are now in use extensively, a clever little wrinkle which is almost imperative in many instances, especially on high-speed drives, is to drill or punch a row of holes in the center of the belt, or two or three rows of holes on wider belts, along its entire length in order to allow the comprest air to escape from between the belt and the pulley and thus prevent undue slippage and waste of power.

The writer has seen another clever stunt and that is to drill one or more rows of small holes around the periferal surface around the pulley or pulleys.

Speaking of belts, there are quite a few varieties which we find here and there, among them spring belts, composed of a spiral spring with the ends linking together; flexible steel and wire core belts and rope belt drives, which are often used for very large horse-powers with high efficiency in connection with grooved pulleys.

HOW-TO-MAKE-IT

This department will award the following monthly prizes: First prize, $5.00; Second Prize, $3.00; Third Prize, $2.00.
The purpose of this department is to stimulate experimenters toward accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $5.00 is awarded; for the second best idea a $3.00 prize, and for the third best a prize of $2.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

SECOND PRIZE, $3.00

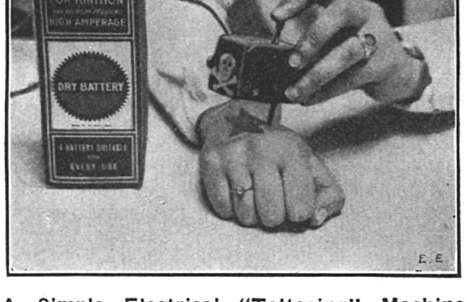
HOW TO MAKE A "TATTOOING MACHINE."

By David T. Weinberg.

PROBABLY the majority of readers have at some time or other seen what is known as a "tattooing machine," but have wondered how one is made and operated. As this article pertains to the construction of such a machine, it can be simply explained as a buzzer permitting the armature of a considerable movement with a new, long and sharp sewing needle attacht to the extremity of the armature with a 3/16 or ¼-inch metal tube acting as a sleeve for the needle and also for containing the coloring fluid.

To begin with we require one small electro-magnet coil wound to a low resistance. This is set on a 3/16-inch thick wooden or better a fiber base.

Next procure a piece of cigar box wood of the same width and thickness and make a housing as shown in the diagram with a few small nails, thus forming a frame so that the armature and vibrator can be attached. Now in attaching the vibrator (one can be obtained from an old bell or at any electrical house), see that it will permit of a long jump, by placing it about ⅛ of an inch away from the magnet, then slot the end of the armature so that the needle will fit firmly into it, and solder carefully, first scraping the parts well.



A Simple Electrical "Tattooing" Machine Which Will Operate On One Or Two Cells Of Dry Battery. The Outline Of a Star Is Here Shown Being Tattooed On a Lady's Hand.

After completing it thus far, hunt up a 3/16 or ¼ inch copper or brass tube, the length being ¼-inch less than the length of the needle, and by tapping lightly and evenly around one end of the tube with a small hammer, taper it down as per the

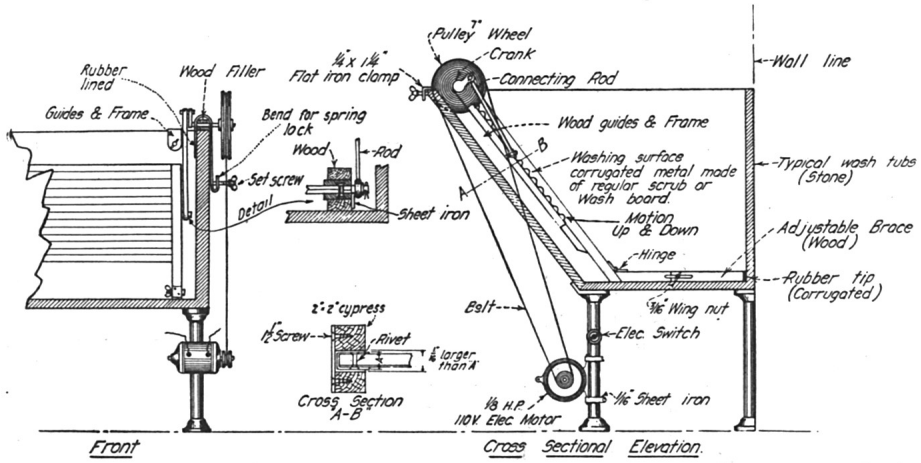
(*Continued on page* 347)

FIRST PRIZE, $5.00

HOME-MADE ELECTRIC WASHING MACHINE.

By P. P. Avery, M.E.

THIS idea is to facilitate home washing of clothes. Instead of the woman doing the rubbing, the board moves up and down and all she has to do is to keep the tubs filled with hot soap suds, water and soiled clothes to be washed and hold them against the moving washboard. Use a small ⅛ or 1/6 H.P. 110-volt motor and wood pulley, with a machine belt run to large 7" wood pulley which is clamped to one of the legs. Arrange a switch near at hand. Make a wood frame, as shown, and using an old scrub-board, bind its edges with a strip of heavy galvanized iron; on the one side make the driving pin fast, and make a connecting rod and crank from ⅛" flat iron, held in place with washers and cotter pins. The board moves freely in its guides as the soft water acts as a lubricant and the frame is held solidly in place by the top wing bolt clamps and by the extension "push-tight" braces. An ordinary lamp cord from wall fixture to switch and thence to motor will duplicate in system the use of the electric iron, and may be used for both.



A Good Home-made Electric Washing Machine, At Last! Instead Of Paying a King's Ransom for An Electric Washer You Can, With a Little Ingenuity and Patience, Construct One of Your Own. The Only Real Expense Is the Motor, and You Can Pick This Up Cheaply At Electrical "Second-hand" Dealers.

AUTHORS ATTENTION!!

We are desirous of publishing in this Department and also in our Constructor Department, the very best articles and ideas which we can obtain. To increase the incentive to authors to contribute suggestions and ideas to the ELECTRICAL EXPERIMENTER—(Science & Invention), we are pleased to offer a new schedule of prizes in this Department, with the present number. Instead of paying $3.00, $2.00 and $1.00 for the first, second and third prizes, we are offering with this number, prizes of $5.00, $3.00 and $2.00 for the first, second and third prizes, respectively.

If you have a good idea send it along! Read the directions for preparing articles at the head of this page, and whenever possible, have the text typewritten. 200 to 300 words are invariably sufficient. Describe the "details"—we will take care of the rest. Address all manuscripts to the Editor, ELECTRICAL EXPERIMENTER.

THIRD PRIZE, $2.00

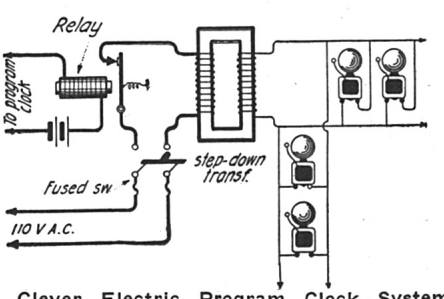
A PROGRAM CLOCK SYSTEM THAT WORKS

By J. C. Jensen.

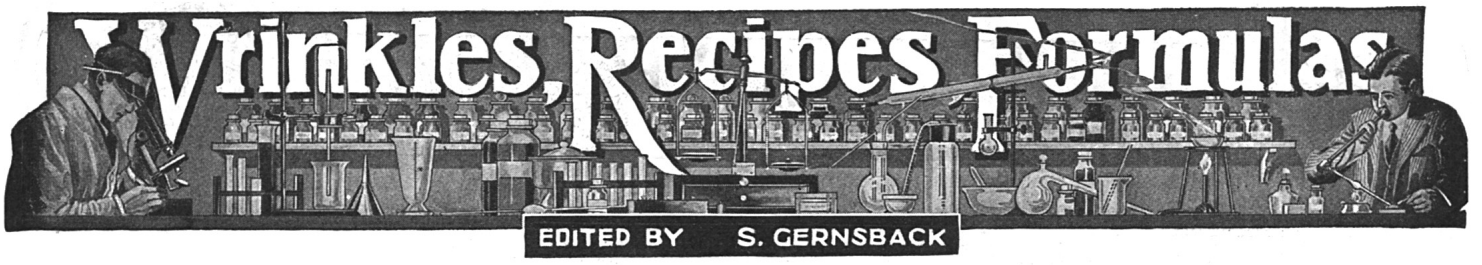
EVERY factory, school or college should have a program clock and a system of electric gongs so that all may know the exact time for the performance of a given duty and work together on schedule time. A bell system operated by hand is subject to all the irregularities of a forgetful janitor. The elaborate electrical clock outfits used in some schools are very expensive and much of the time out of order.

It is not a difficult matter to change the striking system on the ordinary wall clock in such a way that it will trip on each five minute interval, the escapement rotating a *contact-maker* instead of striking the gong, for a three second interval. Several such devices are on the market for those who are not in a position to construct one.

The next problem is that of providing a positive and permanent source of power at minimum expense. The wiring diagram shown herewith solves this problem nicely for one cell of dry battery on the relay line will last for a year and the bell transformer is always on the job with plenty of power for the bells. Common bells work very well if resistances of 20 ohms or more are chosen for a 12 volt circuit, but transformer gongs give better results at little more expense. This circuit has the advantage of minimum danger from fire as the primary circuit is almost always open, and for the same reason the transformer losses are reduced to a negligible quantity. In fact, we have a system of 15 bells and the power cost certainly is not more than 5 cents per month. By placing switches in multiple with the relay lines to the clock, the same bells may be used for fire alarm purposes, switches being placed at convenient points.



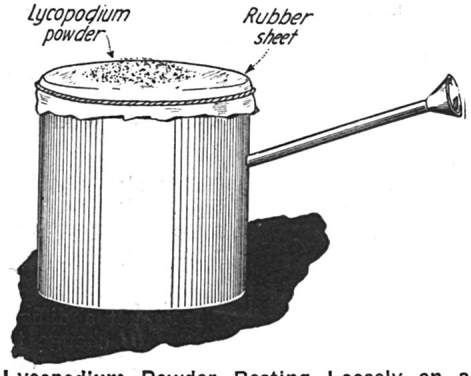
A Clever Electric Program Clock System Operated With Step-down Transformer from 110 Volt A. C. Circuit, Which the Author Is Using In Actual Practise.



HOME MADE EIDOPHONE.

All that is necessary is a clean tin about the size of a two-pound jam tin, also a piece of rubber sheeting, a small funnel, and an oblong piece of tin.

Take your tin and cut a round hole in the side, roll up the piece of tin and insert it in the hole; now solder the tube to the can and stick the funnel in as far as it will go. Take the thin piece of rubber sheeting, and stretch it tightly over the top of the can, and tie it.



Lycopodium Powder Resting Loosely on a Stretched Diafram, as Here Shown, Will Assume Innumerable Figures for the Changing Voice Tones Spoken into the Mouth-piece at the Right.

All is ready and all else you have to do is to obtain some fine powder such as lycopodium powder, dry salt, etc., and spread a thin layer of one of these materials over the sheeting. Now start to sing a single note, steadily and continuously into the funnel and the position of the powder changes and forms itself into a design. The designs thus formed are innumerable, as you can change the tone of voice or the powder as often as you wish.

Contributed by EXWYZED.

COLORED FIRES FOR ENTERTAINMENTS.

The following formulas for colored fires are reliable ones and are used by the large fireworks manufacturers. In compounding them, DON'T mix them with a mortar and pestle. They may be mixt on a large sheet of clean paper. Mix them *thoroly*. Don't pack them tightly in a small space; they are more or less *explosive*.

RED FIRE.

Strontium nitrat	40%
Sulfur	13%
Potassium chlorat	5%
Charcoal or lampblack	3%
Antimony sulfid	4%

CRIMSON FIRE.

Strontium nitrat	53%
Sulfur	22%
Potassium chlorat	20%
Charcoal or lampblack	5%

GREEN FIRE.

Barium nitrat	77%
Sulfur	13%
Potassium chlorat	5%
Charcoal or lampblack	3%
Metallic arsenic	2%

BLUE OR BENGAL FIRE.

Potassium nitrat	66%
Sulfur	22%
Tersulfid of antimony	12%

WHITE INDIAN FIRE.

Potassium nitrat	73%
Sulfur	20%
Sulfid of arsenic	7%

LILAC FIRE.

Potassium chlorat	49%
Sulfur	25%
Chalk	20%
Black oxid of copper	6%

PURPLE FIRE.

Potassium chlorat	43%
Potassium nitrat	22½%
Sulfur	22½%
Black oxid of mercury	10%
Black sulfid of mercury	2%

YELLOW FIRE.

Sodium nitrat	75%
Sulfur	19%
Charcoal or lampblack	6%

All the above percentages are taken by weight. They should be compiled accurately to give best results.

Contributed by JOHN BARRY.

CUTTING THE HIGH COST OF PARAFFIN WAX.

Paraffin wax is used in many manufacturing plants as a sealing compound, and as an insulating medium, also for waterproofing. The present price of paraffin wax is about ten cents per pound, and those using large quantities find this increased price cutting a hole into their profits.

Manufacturers of flashlight batteries use considerable paraffin wax in the construction of the cells as a sealing and insulating medium. Their cost can be cut considerable if they will take say one part paraffin wax and one part rosin. This gives a better insulating material, as well as a better sealing compound. Paper treated with a mixture of rosin one part and paraffin one part, makes an ideal insulation for placing between cells when they are made up in what is known as "battery sets." The same weight of wax when mixed with rosin will treat a greater quantity of paper than the wax alone; this is an additional saving.

The cost of rosin is about $7 per barrel of 280 pounds; this is 2½ cents per pound, and the paraffin wax is not less than 10 cents per pound. So if one pound of rosin is mixed with one pound of paraffin wax this cuts the cost from 10 cents per pound to 6¼ cents per pound, making a saving of 3¾ cents on every pound used. Most factories buy this wax in ton lots, and a saving of 3¾ cents per pound would be the small sum of $75.00 saved on every ton.

Contributed by WILLIAM HOPPIE

"MINIATURE LIGHTNING."

I wish to submit the following experiment which I believe would be of interest to the readers of the ELECTRICAL EXPERIMENTER.

Place a piece of phosphorus about the size of a pea in a glass one-half full of water. Next sprinkle a few crystals of chlorate of potash over the phosphorus. With a medicine dropper release a few drops of sulphuric acid C.P. into the glass. In a few seconds sparks will commence to fly from the phosphorus, and will be accompanied by a snapping and crackling noise which greatly resembles lightning.

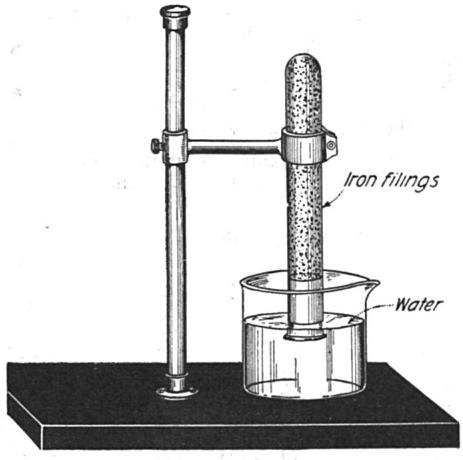
Contributed by MURRAY D. FAIR.

ILLUSTRATION OF OXIDATION BY AIR.

Wet the inside of a clean test-tube with water, and sprinkle a quantity of clean iron filings inside, so that they adhere to the wet glass. By means of a ring-stand, clamp the tube upside down, so that the mouth of the tube is slightly under the surface of some water in a beaker. (See illustration.)

Leave the apparatus in this position for about an hour. At the end of this time, it will be observed that the water has risen inside to about one-fifth the height of the tube.

Explanation: Air consists four-fifths of nitrogen and one-fifth of oxygen; the oxygen in the air imprisoned within the test-tube combines with the iron filings, forming iron oxid (iron rust). The water rises to take the place of the oxygen.



Interesting Experiment to Illustrate the Oxidation of Iron Filings by Air.

To prove the remaining gas is nitrogen, place the thumb over the mouth of the tube, and withdraw the tube from the water. Remove the thumb and apply a lighted match to the mouth of the tube; the nitrogen in the tube will cause the flame to go out.

Contributed by JOHN BARRY.

MAKING FLEXIBLE MIRRORS

Herewith I present directions for making mirrors (flexible) from tinfoil on celluloid.

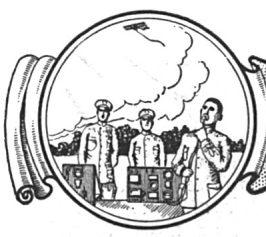
Directions: Procure a piece of celluloid —an old photographic film, cleaned of its gelatin coating will do—and coat it as follows: Make a solution of ¼ teaspoonful of boiling water. Take a piece of tinfoil—not leadfoil—and rub a few drops of quicksilver on one side till it resembles a mirror. Wet the fingers in the prepared gelatin, size and rub it all over the surface of the celluloid, and lay the foil on, *quicksilver side down.*

Cover with a piece of newspaper. Hold it tight to prevent slipping, and burnish the foil down hard to the celluloid surface. This may be done with the end of a round paddle made of wood or similar hard surface.

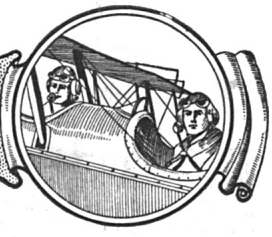
When this has become dry a fine mirror will be the result. It may be twisted in almost any way so that it makes a very amusing device for distorting a person's face, making a stout person look tall and lanky, and making tall people look ridiculously squat and short.

Care should be taken not to bend the celluloid too sharply as the foil will wrinkle and the effect spoiled in consequence.

Contributed by WILLIAM J. WRIGHT.



RADIO DEPARTMENT



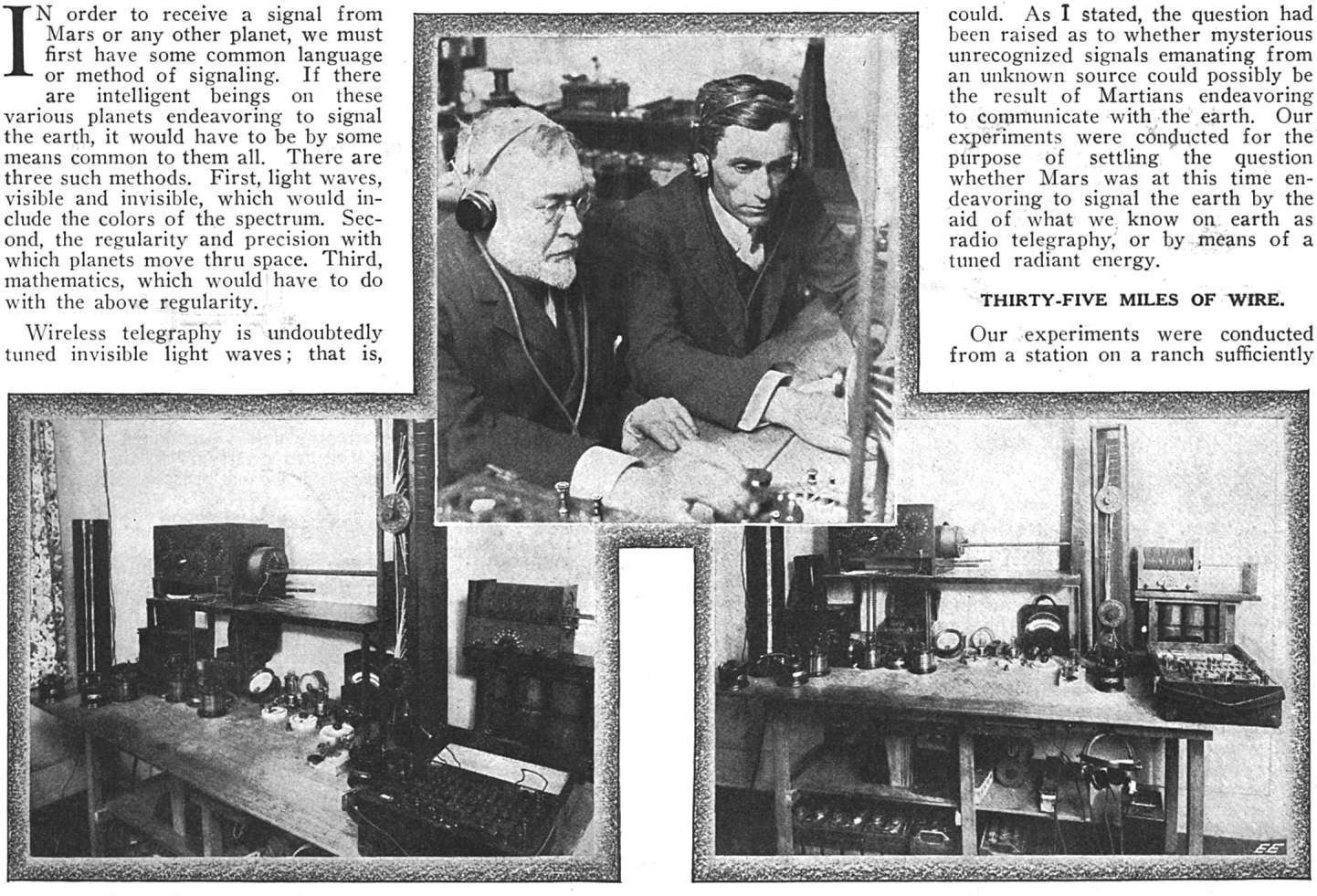
Listening for Signals from Mars

By DR. FREDERICK H. MILLENER

IN order to receive a signal from Mars or any other planet, we must first have some common language or method of signaling. If there are intelligent beings on these various planets endeavoring to signal the earth, it would have to be by some means common to them all. There are three such methods. First, light waves, visible and invisible, which would include the colors of the spectrum. Second, the regularity and precision with which planets move thru space. Third, mathematics, which would have to do with the above regularity.

Wireless telegraphy is undoubtedly tuned invisible light waves; that is, invisible to our eyes. Our scientists have been able by means of spectral analysis to tell us considerable about each one of the planets, and we have no reason to doubt that the inhabitants, if there be any on these other planets, have been able to tell considerable about the earth's spectrum. There is also no doubt that they must know at least as much if not more than we do of the regularity and precision of movement of the planets, stars, etc., and if they do, they must have a thoro knowledge of mathematics or what *we* call mathematics.

From time to time we have heard from the large Marconi stations that they have received signals at more or less regular intervals, the understanding of which was not clear. To a person so inclined there is nothing more interesting than an evening, where the surroundings are suitable for such work, to listen to the humming of the busy world in the ether. With proper apparatus almost any one of the large stations of Europe, North and South America and Hawaiian Islands can be heard, located and messages interpreted. This is doubly interesting if it is coupled with listening for signals from another world. Therefore, when Mars approached as near the earth as it would at this period we determined to listen in, and by building and acquiring certain apparatus secured as long an antenna and counterpoise as we could. As I stated, the question had been raised as to whether mysterious unrecognized signals emanating from an unknown source could possibly be the result of Martians endeavoring to communicate with the earth. Our experiments were conducted for the purpose of settling the question whether Mars was at this time endeavoring to signal the earth by the aid of what we know on earth as radio telegraphy, or by means of a tuned radiant energy.



Photos Show the "Mars" Listening-in Radio Station of Dr. Frederick Millener. Dr. Millener Appears at Left of Top Photo—the Gentleman at Right is Mr. Harvey L. Gamer, His Co-Worker. Both are Leaders in the Field of Radio Engineering.

DR. FREDERICK H. MILLENER, radio expert and the first man in the country to establish radio communication with a moving railroad train, during his famous experiments on the Union Pacific Railroad, needs perhaps no introduction to our radio readers.

During the last opposition of the planet Mars in the latter part of April, the entire world was breathlessly awaiting news from Dr. Millener's Omaha station whether the mysterious planet was actually trying to communicate with the earth. Scientists were agreed upon it that if anyone was able to detect these signals Dr. Millener's station certainly would be able to register them, due to his very fine instruments as well as the excessive wave length employed. For days the newspapers were full of Dr. Millener's work, and the world was awaiting news expectantly. That the result was negative is of course no fault of our scientists. If Mars had been sending radio signals such as we understand them, Dr. Millener's station would have received them. Our readers will be glad to read Dr. Millener's own account which has been written especially for the ELECTRICAL EXPERIMENTER.

—EDITOR.

THIRTY-FIVE MILES OF WIRE.

Our experiments were conducted from a station on a ranch sufficiently far from Omaha, so that local electrical disturbances would be entirely absent. A large part of the equipment was constructed especially for the purpose to which it was put by my co-worker, Harvey L. Gamer and myself, both of whom had been connected with the Union Pacific Railroad as experimental engineer and electrical engineer before the war; Mr. Gamer during the war. Part of it was apparatus that was used at Fort Omaha, Nebraska, to listen in and detect unlawful users of the ether during the war. It consisted of a large co-axial coupler, amplifiers, both radio and audio frequency, inductances and condensers. The antenna consisted of *approximately thirty-five miles of wire strung on telegraph poles, covering an area of about twenty-five square miles,* and the counterpoise somewhat larger. We were enabled to reduce the size of our antenna and counterpoise at will, thus permitting us to pick up the messages of almost any wavelength and accurately measure the same. Starting with the wavelength of an average commercial station we gradually lengthened our wavelength until that of New Brunswick and Annapolis were reached and past. Slowly increasing the wavelength until it

(*Continued on page* 317)

A War-Time Radio Detective

By PIERRE H. BOUCHERON

No. 3. Sleuthing a La Twentieth Century, or Trailing the Illegal Dot and Dash Slingers

FORTY years from now, when I am old and crabbed; when I no longer take pleasure in making home brew; when I shall have ceased experimenting with permanent electro-magnets on the electric light meter, and when my eyes shall have become dim and watery from close contact with sputtering arcs and X-ray machines to such a point that they will cease to appraise wondrous landscapes, art galleries, the language of the birds and flowers, beautiful women, near-beer and other works of nature and prohibition, I shall have my nurse-maid bring forth my diary and turning back to the experiences entitled "The part I played in the *Grate* War," shall have her read me to good cheer some of the many little comedies connected with my "radio-sleuthing" days.

. . . . "Mrs. S—— Lived Near Rochester, N. Y., in an Old Colonial House . . . She Led Me Into the Musty Old Parlor and Unfolded a Startling Recital of How She Had Received Radio Messages Direct from the 'Central Powers'—All Without Any Apparatus!"

Every time I swallow a false tooth, I shall want to be brought back to pleasant humor by insisting upon being read the passage about the nice old soul who once sent our bureau a 200-word *day telegram* to the effect that she had information of the greatest value to the Government of the United States, both from a scientific and military point of view, and that we make haste to visit her as soon as possible in order that she furnish us with all particulars. She did not forget, of course, to mention the fact that the matter was so startling and would prove so revolutionary that she could not even hint as to its nature in so open and public a method of communication as an ordinary telegram. The lady further stated that the case had to do with a totally *new system of radio telegraphy*, and for that reason no less than an expert in this science should be detailed on this important mission.

After this yarn has been read off to me, I shall contentedly sit back in my easy chair and perhaps take a few sips of weak tea, who knows? The story runs something like the following:

THE STRANGE RADIO TELEPATHIC SIGNALS.

Mrs. S—— lived near Rochester, N. Y., in an old house of the colonial days type. No sooner had an aged negro servant admitted me than the gloom and silence of the musty Revolutionary mansion began to weigh heavily on me in addition to the six-dollar raincoat on my back. I waited almost an hour when the lady finally made her appearance and greeted me with an air of dignity and low tones which seemed to spell mystery with a capital "M."

She led me to the old fashioned parlor and thereupon unfolded one of the most startling and fantastic recitals it has ever been my bad fortune to hear. *For the past two weeks she had received many messages direct from the Central Powers.* She explained that altho the messages were transmitted by means of radio-telegraphy thru the high-power stations at Berlin, Constantinople and other points, she had accidentally discovered a means of receiving them direct *without the use of an actual radio installation!* At this statement, I looked at her sharply, then began to look around for a quick exit to the nearest door. The odd part of it all was that the woman seemed perfectly rational and spoke in a well-informed and balanced manner, and no amount of questioning on my part failed to disclose the slightest trace of that well-known malady, *dementia americana.* To cap the strangeness of her story, she brought forth a number of sheets of paper containing all manner of messages written in several languages, evidently of an official character, judging from the various military and civilian titles.

I asked the lady just how she received these communications, at which she answered, "Why, by means of dots and dashes, of course. I have always been an expert operator, and there is no mistaking the manner in which the signals respond to my hearing."

For another whole hour I was forced to listen to many descriptions of just how the messages "came in," which were mostly at night, she said. The woman seemed so sincere that I began to have my own doubts. I remembered several instances in my operating days, when there had been times, when miles away from any radio apparatus, I *thought* I could hear familiar high frequency spark signals. Perhaps some radio men who read these pages may recall similar occurrences. Strange, but nevertheless true. So, as I say, I began to wonder whether the lady was not suffering from some exaggerated form of a similar delusion confined solely to the sense of hearing.

Finally, I gathered all the data offered me, made a few notes on the time and place of the strange *radio-telepathic* signals and fearing to be informed of more *startling and revolutionary* radio doings, I managed to make my exit with as much grace as I could command under the circumstances. Once out in the open country road, I breathed a sigh of relief, wiped the moisture from my almost "fevered brow," and started for the nearest house adjacent to the spooky Mrs. S—— in order to confirm certain thoughts.

Before I reached it, however, the rural mail carrier came jogging along in his buggy.

"Can you give me some character information on the lady living in that old homestead?" said I, pointing to the house in question.

"Sure," he promptly answered, "it's old Mrs. S——. She has been harmlessly but hopelessly mad for the past ten years. Her husband was a scientist of the old school, so she now imagines herself as carrying on his work, and she seems particularly cracked on subjects connected with mental telepathy."

"Thanks," I said, as I mentally resolved to prepare a long report to my superiors urgently recommending that in the future no attention be paid to the communications of informants unless accompanied by original certificates certifying to the sanity of the man or woman responsible for its dispatch.

STOCK "SIGNALS."

One day, while intensely interested in a lifelike description of some artistic subject within the pages of the "Follies Gazette," an urgent call reached us to immediately dispatch an expert signal man to a certain building in the downtown section of New York, where a telephone inspector was in the very act of listening to some authentic and quite audible "radio signals" having no business there.

Upon reaching the place, I found my telephone friend pottering and fuming over a large connection box on the main floor of the building. He was sure they were radio signals because he once had met a man who had told him all about it. As far as he was concerned, there certainly was *no room for doubt,* and accordingly, had telephoned his chief to come down and listen-in for himself.

Since this incident had occurred during one of the periods most pregnant with spy radio hysteria, these two gentlemen had lost no time in notifying official headquarters. With the aid of a telephone receiver I listened-in on an improvised circuit in the telephone box, to which ran many thousands of telephone wires. Sure enough, signals of a suspicious character were distinctly audible. They had a frequency of about sixty cycles, were quite loud, but hopelessly, pathetically and, as usual, *inevitably* unreadable. As I listened for a little while longer, the signals, which were composed mostly of series of long dashes with a few dots here and there, slowly began to assume the character of something I had once or twice heard, which sounded suspiciously like a certain instrument near the barroom of the Estor Hotel. You may remember, of course, that this well-known hostelry had, during the same year, been the scene of a suspected spy radio installation, not far from its immense roof. As the suspicion slowly began to impress itself on my mind, I asked one of the wire experts if there were any other lines besides telephone circuits within or near the connection box. He replied there was nothing

at all except a so-called "ticker" circuit.

"Ah!" I exclaimed, as the previous suspicion now became alive with possibilities, "that is just what I want; where is it?"

I thereupon made some sort of connection on the ticker circuit and was not surprised when I heard the sounds within the telephone receiver *absolutely identical* to those we had heard on the adjacent telephone wire. In other words, the signals were none other than those which had fooled us many times before, and I may say many times thereafter. In short, they originated from *stock ticker* circuits. In sections where these ticker wires were allowed to run close to telephone circuits inductive effects often resulted, whereby the familiar "da-da-di-da-da" of the news and stock tickers, you and I have frequently heard, were induced on adjacent telephone lines.

MYSTERIOUS STEEL TOWER IN THE CATSKILL MOUNTAINS.

Occasionally there would be cases which, during the process of investigation, would manage to get into the hands of newspapers. The result of course was that great notoriety would be given to instances which were nothing more or less than the overzealous activities of patriotic and well-meaning persons.

Such conditions would particularly be noticed after the press had given much space to one or two of these fiasco cases. A case of this nature was the following one, which took considerable time and expense to unravel. Three reports came in from three different sources reporting the one individual case.

A millionaire woolen manufacturer who, rumor intimated, had had his manufacturing plant confiscated by the Government, and which was now being operated by the office of the Alien Custodian had, previous to our entry into the war, been engaged in much German propaganda.

This gentleman was now living in a secluded and almost inaccessible spot somewhere in the Catskill Mountains. Here he had fortified himself by building a large and expensive mansion, surrounded by all the comforts characteristic of millionaires. The informants had heard from undoubtable sources that this German had constructed and was operating a *high-power radio outfit, capable of sending and receiving messages to and from Germany!* The report also said that he had a large steel tower, under the guise of a windmill, and that from this tower was stretched several lengths of wire to neighboring tall trees which acted as an antenna. A large generating plant had also recently been forwarded to this spot as well as many other electrical appliances.

One of the informants claimed that he had climbed a certain high spot near the German's place, called "Watch Hill," where he had *seen* the tower and wires very distinctly. It could also be noticed that a wire fence had been built around the estate and that large, ferocious dogs, assisted by evil-looking individuals, patroled this enclosure during the day and night in order to scare away possible intruders.

After reading these reports, the case certainly looked very promising and inferred possibilities of a great discovery. The only way to reach this place was by train which left New York at 2 a. m., and which reached a place called *Big Indian* at about 11 a. m. From this point it was necessary to board a stage (a Ford truck used by the local postmaster) and travel thru many winding roads for a distance of nearly thirty miles. I finally arrived at a spot within a short distance of the suspected estate, accompanied by a secret service man. We were prepared for a long siege and had the necessary equipment, such as revolvers, powerful field-glasses, and a small portable receiving outfit.

In order to allay suspicion as to our purpose, we explained to the stage driver that we were on a fishing trip and our paraphernalia consisted of supplies for a long ramble thru the mountain streams in search of trout. We reached the base of Watch Hill late in the afternoon and decided to start our investigation after midnight. We climbed the "Hill" and installed ourselves near the top, where we had an excellent view of the estate, as well as the steel tower. Upon closely scrutinizing the ground with our field-glasses, we saw the power house in question, separated from the mansion by a short distance, and what were evidently power lines leading to and from the house.

Articles In July "Radio News"

Radio Telephony on Aeroplanes.
By Major C. E. Prince.

Concerning Aerials.
By P. H. Boucheron.

The President's Special.
By Thomas W. Benson & Chas. S. Wolfe.

An Experimental Wave Tester for Receiving.
By Raymond Evans.

Radio in Germany.
By R. Wilhelm.

The Wavemeter and Its Importance in Radio Transmission.
By Yosé.

Musical Reception with Continuous Waves Without Local Oscillations.
By Dr. L. W. Austin.

We also observed that there were considerable lengths of wire attached to the steel tower, leading to distant trees, all seeming to be of standard length, as would be with a systematic attempt to secure a definite wave length, and the terminating ends also seemed to have large dark objects which closely resembled insulators. However, from the distance we were, we could not definitely establish whether or not these objects were actually insulators or merely twist-bolts.

At midnight we closely observed the place under investigation and noticed considerable activity, such as lights burning and persons walking to and from the power house, which in itself looked at least suspicious.

After this, we erected our portable receiving outfit and listened-in for the remainder of the night. However, nothing was heard which would preclude high-power transmission in the immediate vicinity. In fact, constant and careful observation for the following three days failed to furnish any conclusive evidence that our friend was engaged in anything more alarming than scientific farming and tree planting, aided by several gardeners and laborers.

We therefore decided to "swoop" down on the place and to make a thoro investigation of the power house and that suspicious-looking tower and wires.

The owner of the place was considerably annoyed when we explained our visit, and at first was going to have us thrown out, but when we explained to him the futility of doing this, he consented to allow us to go thru his place in order to demonstrate to us the absurdity of the reports that he was a German agent engaged in receiving and sending military information between Germany and the United States. He accordingly detailed his private secretary to accompany us in our search.

Alas for the vagaries of humans and the vividness of their imagination! What we had thought would mean the making of our fame while unraveling this mystery and discovering a den of German propaganda, proved only to be another story enough to give us a press notice of not more than two lines.

The tall steel tower was in reality a windmill and the wires separated from it were nothing more alarming than guy wires. The suspicious-looking objects at their termination were turn-buckles, designed to take up any sagging of the guy wire.

As for the power house, it was indeed genuine, but was used solely for the purpose of illuminating the house and surrounding barns as well as to furnish power to the many appliances necessary to a modern and up-to-date millionaire's estate.

Our German friend invited us to luncheon and he certainly exceeded himself to make us comfortable, including cigars, afternoon coffee and liqueurs. Under the genial influence of this meal, served to us by a butler in a gorgeous uniform, our host waxed genial and really was amused with the absurdity of his being *under suspicion.* He thought he knew who caused the report to be sent in. Probably a discharged employee, and he vowed he would investigate the matter himself in order to get at the bottom of it, to definitely prove to us that he was a true friend of the United States. He was a naturalized American citizen and had most of his money invested in Liberty Bonds. Not only that, but he had turned over his entire manufacturing plant to the Government for the manufacturing of khaki and incidentally had invented a new kind of cloth which was more serviceable, more economical and more efficient than any of the cloths used by the European countries.

Yes, critical reader, I fully realize that the Lightning Rod and the Underground Radio episodes promised last month are missing in the present issue. Be reasonable, as I have not yet received permission from the German War Office to publish them! In the next installment you will be rewarded with a few more choice exploits.

"We Reached the Base of 'Watch Hill' Late in the Afternoon . . . . . Where We Had an Excellent View of the Estate, as Well as the (Spy Radio?) Tower."

Left:—The Wireless Plant at "Knights of Columbus" School in New York City, Where Electricity, Acetylene Welding, Motor Mechanics and Other Vocational Trades Are Taught Free to the Demobilized Service Men. Right:—The Electrical Class of Ex-fighters in a K. of C. Vocational School Observing a Problem for Interior Wiring. This Course With "Radio-telegraphy" is One of the Most Popular in the Chain of Sixty Such Schools Operated Free for the Former Fighters.

Free Radio Course for Ex-Soldiers

By William M. Bolger

FIFTY thousand soldiers who served at home and abroad during the World War and were thrown back into civilian life to be classified among the "unskilled workers," of this nation of 100,000,000 souls have been taken in hand by one of the most unique educational systems ever launched in this country and are now well on their way ready to take their places in the factory, round-house, construction and various skilled trades.

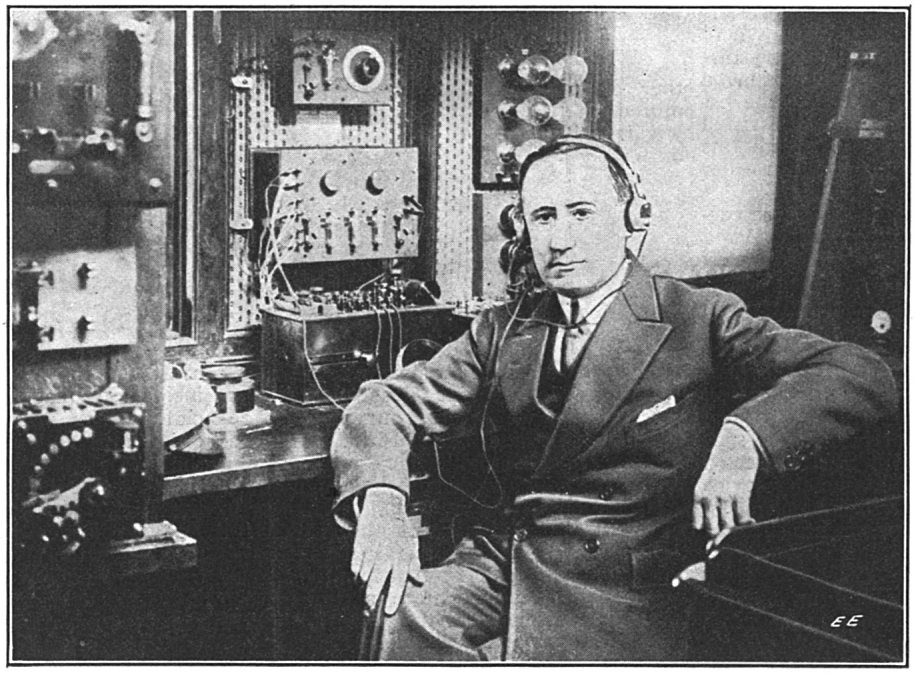
It happened not more than one year ago when the Knights of Columbus found the portals of peace about to be dropt on one of the most brutal wars the World ever stood up before. Every patriot in this country had done their share. Those who could not go gave unstintingly of their funds so that the soldiers, sailors and marines overseas might have some proper attention through the many war relief agencies which had sprung up with the clash of arms. Foremost in this field came the Knights of Columbus with their cheery slogan of "Everybody welcome; Everything Free." They gave millions of dollars worth of creature comforts to the men and at the end found a balance of seven million dollars on their books which remained to be spent.

From this fund and thru the formation of a committee of educational experts from all sections of the country, the idea of the supplementary Vocational and Elementary Evening Schools was conceived and put into practical operation. A chain of sixty schools from the Canadian border to the Rio Grande and across to the Pacific are now functioning at top speed. Any service man or woman simply presenting a discharge certificate showing the applicant has been "in the service" is all that is necessary for the admission of a pupil. The schools are in session five evenings each week and the study periods are divided between 7:30 and 9:30 each evening. No religious or racial lines are drawn. They are operating schools for the negro soldiers apart from those for the Southern boys. In their vocational schools they have given great attention to the studies of advanced motor mechanics, electricity and radio-telegraphy, because many of the ex-service men and women display enthusiastic interest in these subjects. The attendance of the students averaged up in these courses at the many schools shows very little sign of declining. William J. McGinley, the Supreme Secretary of the K. of C., is at present completing a tour of certain schools for the purpose of making a survey that will allow for intelligent development this coming Fall, when more schools will be opened and new studies brought in.

One of the attractions of the school system is that all pupils are allowed to pick any particular course in which they are interested. And the other attraction provides that any student upon completing the study may choose a new one free.

Marconi--The Master Radio Experimenter

Signor Guglielmo Marconi, the famous inventor of applied Radio-telegraphy, is still as enthusiastic as ever, when he sits among his instruments and he truly may be called, the "master radio experimenter." Signor Marconi, unlike many inventors, has had a very fine education in the various branches of science, pertaining to the subjects in which he is interested, and holds the degrees of D. Sc., and a number of other high scientific honors bestowed upon him by various universities thruout the world. The inventor of applied wireless telegraphy is seen in the accompanying photo, on board his palatial ocean-going yacht, and recent news reports have intimated that he intended sailing out on the ocean so as to be as far as possible from all earthly radio stations, in order to make further careful tests of the mysterious Martian (?) signals.



The Accompanying Photograph Shows Signor Guglielmo Marconi Seated in His Radio Laboratory on Board the Palatial Marconi Ocean-going Yacht. Despite His Advancing Years, Signor Marconi Is Just as Enthusiastic an Experimenter as In His Younger Student Days, When He Raised the First Elevated Antenna Wire on His Father's Farm, and Discovered That the Hertzian Waves Would Carry Signals a Mile and More, Instead of Just a Few Feet, the Distance Covered by Lodge and Other Previous Experimenters

Three Types of Amateur Spark Gaps

By PIERRE H. BOUCHERON

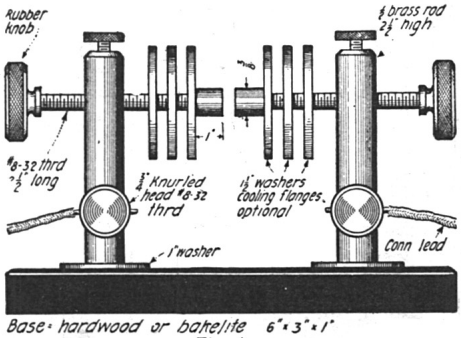
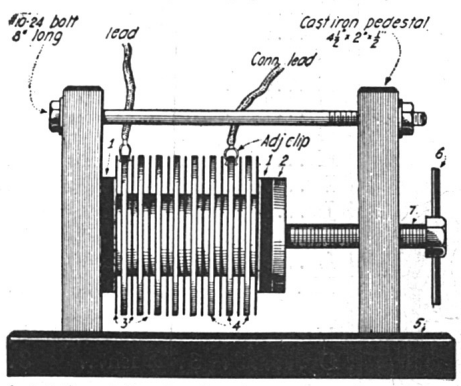


Fig. 1

Plain Fixed Spark Gap, Fitted With Cooling Flanges or Vanes.

WE shall begin by refreshing the memories of some radio beginners. The spark gap may be likened to a trigger allowing high voltages to pass thru at a certain time. In other words, altho there is an actual air space across the electrodes of the gap, it forms and is always a part of the high frequency oscillations produced in the primary circuit of a transmitter. This air gap is broken down only at such time as the transmitting condenser has become fully charged by the high voltage supply from the spark coil or transformer. Thus *when once broken down* it readily allows the condenser to discharge itself. As soon as the condenser has become fully discharged, the gap opens once more and is given a chance to cool off slightly before the next condenser discharge takes place. Therefore, the gap is a conductor during a fraction of a second and is a non-conductor during the next time interval. If this were not so, the condenser would not be able to charge itself again and an *oscillatory circuit could not be maintained.* The rapid restoring of the gap to this non-conducting state is, therefore, called the *quenching action,* and for that reason all gaps, no matter what type, quench to a more or less perfect degree. An arrangement which performs this task very effectively, and which has come into general use with spark transmitters, is the so-called quenched gap. It was given this name because of its ability to perform the quenching action with remarkable rapidity and efficiency.

We will now describe three forms of gaps each having its own particular use and adaptability; in other words, the plain two-electrode spark gap, the non-synchronous rotary spark gap and the quenched spark gap.



1- Bakelite end pieces. 2- Metal end piece. 3- Insulating gaskets. 4- Plates. 5- Base 10"x6½"x2" 6- Handle. 7- ⅜"-32 pressure bolt

Fig. 3

The Genuine Quenched Spark Gap—Each Gap Airtight and Mica Insulated. Open Gaps Only Partially Quench.

THE PLAIN SPARK GAP.

This gap on account of its simplicity may be readily constructed by the average experimenter and does not require much material. It is suitable for spark coil transmitters and may also be used with small transformers up to one-half K. W.

Fig. 1 shows the general construction details of such a spark gap. The base may consist of a piece of hard rubber, marble, bakelite or hard, well-seasoned wood. In this case it is 6 inches long, 3 inches wide and 1 inch thick. The two uprights can be made from half-inch brass rods each 2½ inches high. One-half inch from each top holes are drilled and tapt with an 8/32 thread so that tapt rods may be employed as electrode adjusters. The electrodes proper may be secured by cutting two small lengths of battery zincs and also tapping them with an 8/32 thread. The cooling fins or flange shown in the figure may be employed, altho they are not absolutely necessary. They have the desirable effect, however, of rapidly dissipating the heat generated at the spark points and therefore keeping the gap comparatively cool, *thereby helping the quenching effect.* These fins may be in the form of several one-and-a-half or two-inch brass or copper washers, also tapt, so that they may be adjusted equi-distant from the zinc electrodes as shown. By means of the adjusting knobs the gap distance may be adjusted almost minutely, thus insuring proper sparking distance under any given condition.

The noise from an open spark gap is sometimes very annoying, particularly to the less enthusiastic members of one's family. An effective *silencer* may therefore be easily made by securing a short piece of glass tubing one-half inch in diameter or more of the glass gage type, having wooden or rubber ends fitted to it just large enough to admit the gap electrodes, thus completely enclosing the spark gap.

THE NON-SYNCHRONOUS ROTARY GAP.

This type of spark gap is the one mostly used by the up-to-date amateur as it has the advantage of raising the natural pitch of ordinary sparks, the never-ending desire of the real enthusiast being to have as high and clear a note as possible. Another advantage of the rotary gap is that on account of its high speed and fanning action it is singularly free from arcing. Still another desirable qualification is that the emitted spark note may be changed at will by varying the speed of the motor with an appropriate rheostat. There are many types of rotary gaps in use at the present time, but their fundamental principle is practically the same; that is to say on the shaft of an electric motor is arranged a metal disc having a series of projecting points which revolve between two stationary electrodes, one on each side of the wheel and where the spark jumps across these. The note is therefore dependent upon the number of times the spark is interrupted by the revolving wheel.

In Fig. 2 we have a type of rotary gap which has been found very efficient for low power amateur use, particularly for the employment of short wavelengths. For as will be seen from the illustration, it is not necessary for the high frequency oscillations to travel thru long metal discs, arms or other parts of the gap structure, and in some cases a direct saving of over ten meters is effected.

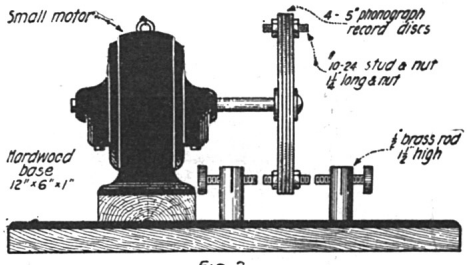


Fig. 2

An Effective Rotary Spark Gap, Having the Shortest Possible Path Thru the Gap Members.

A bakelite or marble base may be employed in this instance, having the dimensions of, let us say, 12 inches long, 6 inches wide and ½ inch thick. A small fan motor may be employed, preferably one of about 1/16th horsepower which will give about 6,000 R.P.M., using either A. C. or D. C. according to the power available. Battery motors may also be employed, but where regular A. C. or D. C. is available, 110 volt motors are preferable. On the end of the motor shaft is mounted a four or five-inch composition disc. This may be either bakelite or two small phonograph discs may be used jointly with equally good results. In drilling the latter, however, great care must be taken not to split or crack them. Twelve holes are drilled near the edge of the discs *an equal distance apart* and thru these are fastened twelve 1½-inch brass screws of the 10/24 variety or larger, after having first cut off or clipt each head. Nuts are fastened on each side and tightened securely making the two discs a compact unit. It is, of course, essential that all protruding ends of the screws be exactly of the same length. If they are found to be of unequal length, they should be carefully filed down so that they will pass by the stationary electrodes arranged on each side of the disc in precise and equi-distant order. After the gap has been completed, the sparking distance is regulated by means of the adjustment screw on each one of the electrode standards. By following the general plan laid out in Fig. 2, the experimenter will obtain a fair idea of the essential parts and their arrangement so that further construction data is not necessary.

THE QUENCHED GAP.

The quenched gap is in reality a series of very small gaps, enclosed in such a man-

(*Continued on page* 334)

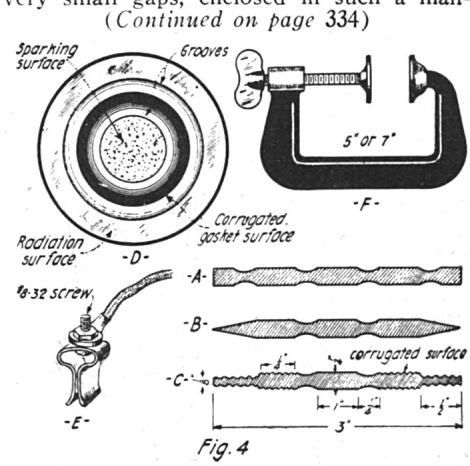
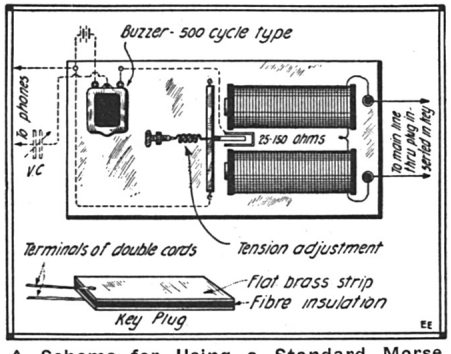


Fig. 4

Hints and Construction Details on the Quenched Spark Gap.

USING MORSE RELAY FOR CODE PRACTICE.

Here is a way for the "bugs" who are employed in or have access to the main circuits of a telegraph office, to keep up their wireless practise, or an excellent way in which to learn to read signals wirelessly. The following involves the application of a Morse relay, and is nothing more than a simple relay system, from sounder to 'phones.



A Scheme for Using a Standard Morse Telegraph Relay for Telegraph Code Practise. The Relay Operates a Hy-tone Buzzer and Receives Its Current Impulses from Any Telegraph Line, by Means of the Special Plug Inserted in the Key.

As the diagram shows, the coils of the relay (which may be of varying resistance, from 25 to 150 ohms, altho about 75 is best), are connected in series with the main line thru a jack plug inserted in the key. This plug is the same as used on the Vibroplex or other types of sending machines in telegraph service, or may be easily made as per the diagram.

A 500 cycle note buzzer is connected in series with a dry cell and thru the make and break contacts of the relay. Your wireless 'phones are connected one terminal to the third or middle post of the buzzer, the other terminal to one side of the battery thru a variable condenser. The variable is for tuning the strength of the signals desired.

It will readily be seen that any signals coming from the main line will pass thru the coils of the relay and actuate the armature, which in turn opens and closes the buzzer circuit, reproducing the dots and dashes in the phones wirelessly. The buzzer, and the condenser (if removed from the case) can be neatly mounted upon the base of the relay.

Contributed by PENUEL E. BALLARD.

HAVE YOU A "WIRELESS" SCRAP-BOOK?

Here is a suggestion which will be valuable to experimenters: For the last four years I have spent spare moments in making a "Wireless Scrap-book." To date it contains over 800 pictures, hook-ups, tables and articles of interest not only on wireless, but nearly everything in the electrical, mechanical and chemical line. Proper grouping of the subjects will show the advance in these fields, and the value of such a book would be difficult to estimate.

The wireless scrap-book idea is one which can be followed by several different ways. Some people simply buy a cheap copy book or obtain an old account book, etc., and proceed to paste in wireless pictures, which they happen to see in magazines, newspapers, catalogs, etc., but the real use of such a book will be found only when it is properly indexed.

Contributed by
ALBERT LEE WOODY.

ANTENNA, RADIATION AND GROUND RESISTANCE.

The antenna had a capacity of .00126 mf; inductance of 43 mh, and a fundamental wave-length of 440 meters.

Wave-Length.	Antenna Resistance.	Radiation Resistance.	Ground Resistance.
400	26.0	14.0	6.5
500	19.0	9.0	7.5
600	16.0	6.7	9.0
700	14.9	4.9	10.1
800	15.0	3.5	12.0
900	15.8	3.0	13.5
1000	16.9	2.5	14.8
1100	18.0	2.0	16.0
1200	19.0	1.8	17.5
1300	20.2	1.7	19.0
1400	21.5	1.6	20.2
1500	22.5	1.5	21.9
1600	24.0	1.4	23.0
1700	25.5	1.3	24.6
1800	27.0	1.2	26.0
1900	28.4	1.1	27.8
2000	30.0	1.0	28.7

In the data presented below it is shown that while the ground resistance increases gradually for each increase in wave-length, the radiation and antenna resistance drop, until around 700 meters the antenna resistance begins to increase again, setting the same pace as the ground resistance for the remainder of the test. The radiation resistance decreases gradually until reaching about 1100 meters, where it decreases more slowly and at a more uniform rate. Between 600 and 700 meters seems to be the logical working point for this antenna under measurement. This data is from actual laboratory tests made by the U. S. Navy.

Contributed by E. T. JONES.

HOW FAR AWAY IS THAT CALL?

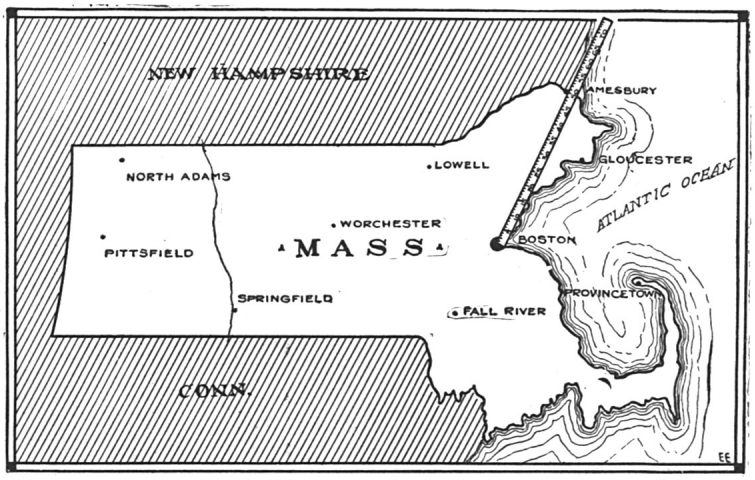
I had always wondered how far away this or that station was until this little device was put up in my station.

A man of the state was tackt on the wall and a ruler or scale made which had marked off on it the number of miles according to the scale given on the map. A thumb tack was put thru the "O" mile point and this tack also was stuck on the point on the map which represented the home town. When this rule was swung around, the distance to any of the towns was shown when the town point came flush with the edge of the ruler.

Maps may be secured from the government at Washington, of your county, state, section or of the entire country. The charge is nominal.

An improvement would consist in making the scale of transparent celluloid, scratching or engraving the figures and division marks into the surface so that the ink used will be held firmly and not easily rubbed off.

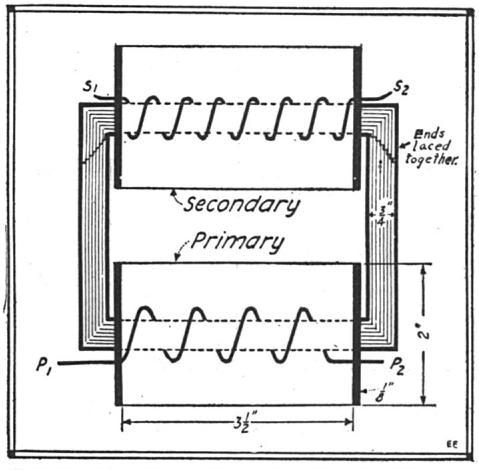
Contributed by "BIX"



Here Is a Nifty Way to Quickly Determine the Distance Between Your Home Town or City and Any Wireless Station You May Hear. A Piece of Paper Is Laid Off with a Scale of Miles Corresponding to the Map Scale Used. This Strip of Paper Can Then Be Anchored with a Pin or Thumb-Tack to Your Home-Town Spot on the Map and When Swung Around the Mileage to the Various Towns Can Be Read Off.

TRANSFORMER USING SPARK COIL PARTS.

A 110-volt, 60-cycle transformer from parts found around the average experimenters' work shop can be built at practically no cost. It will give good results when used for Radio Work or in connection with



Details Are Here Given for Constructing an Efficient Closed-Core Transformer, Using Parts from Old Spark Coils.

High Frequency experimenting, etc. A secondary coil from an old type Atwater-Kent Ignition Coil (or any large secondary) is used as a transformer secondary. Obtain enough soft iron wire, No. 18 or 19, to make a core ¾ of an inch in diameter and 11½ inches long. Three and one-half inches in the center of this core is to be used for a primary winding. The core should be well insulated for this length.

Make two fiber end plates one-eighth of an inch thick by two inches square with ¾-inch hole in center, slip these over core 3½ inches apart. Wind this space full of No. 20 magnet wire and bring out leads.

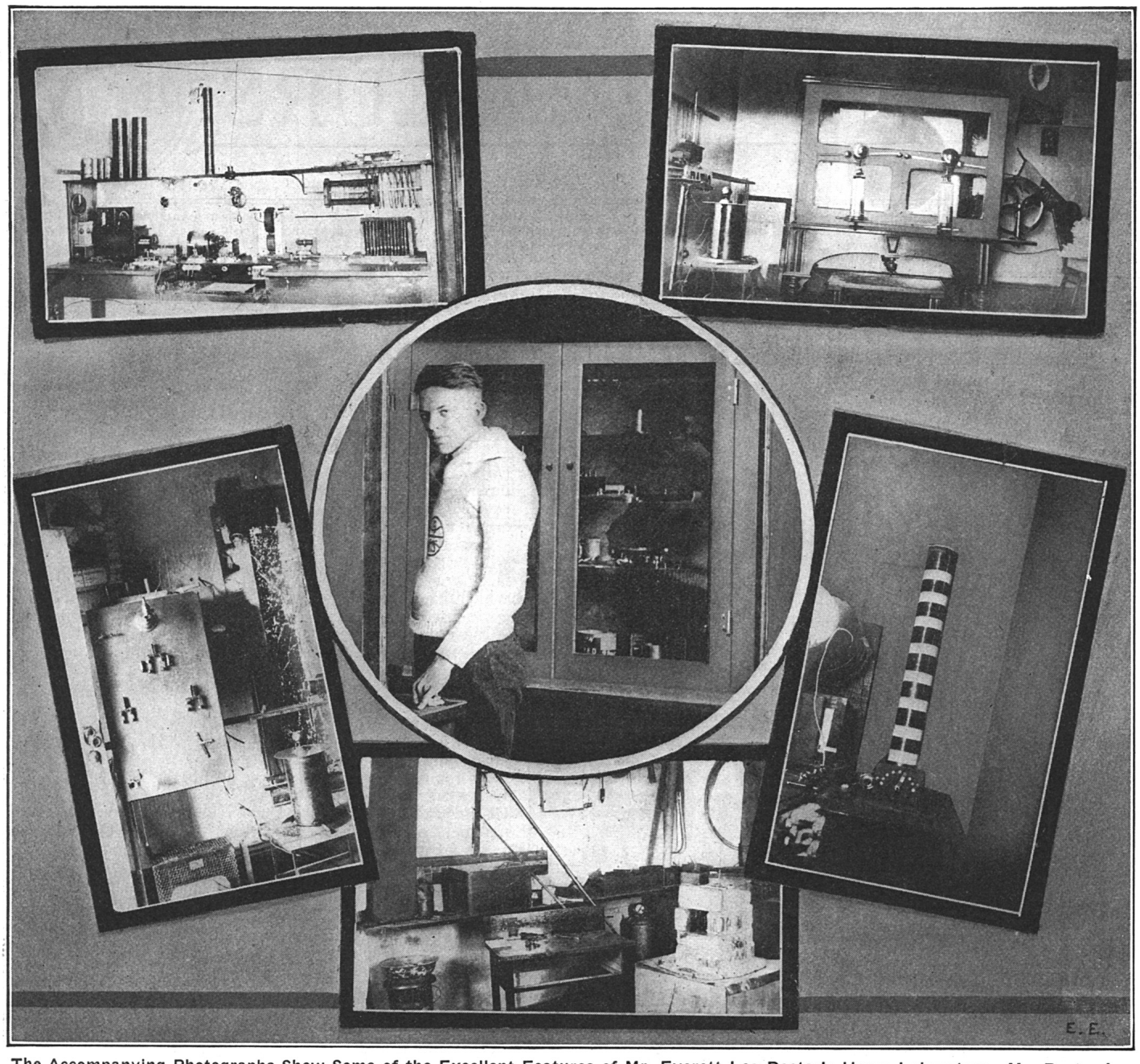
The wire and insulation are removed from the old core which is then placed in the secondary, the remaining space is filled with soft iron wire, the core being well insulated from the secondary winding.

Contributed by E. W. LETPER.

A NEW TELEGRAPH CODE

This code can be used to convey messages to and from any distance either over the telegraph wires and operated by keyboards, or they can be flasht by light, bells, whistles or rappings and from the letter E to Z there is a slight pause between each dot. There are no dashes. Those beyond the letter Z to No. 1 are straight dots, as indicated. Then the No. 1 to 9 and 0, the dots are made with a slight pause between the first and second dots, etc. Copyrighted, 1915, by Alfred A. Wright:

ALL DOTS		NO DASHES	
A	1.	P	3. 4.
B	2.	Q	4. 1.
C	3.	R	4. 2.
D	4.	S	4. 3.
E	1. 1.	T	4. 4.
F	1. 2.	U	5. 1.
G	1. 3.	V	5. 2.
H	1. 4.	W	5. 3.
I	2. 1.	X	5. 4.
J	2. 2.	Y	6. 1.
K	2. 3.	Z	6. 2.
L	2. 4.	Period.	5.
M	3. 1.	Comma.	6.
		Question	
N	3. 2.	Point...	7.
O	3. 3.	Dash...	8.
No.		No.	
1	1. 5.	6	2. 5.
2	1. 6.	7	2. 6.
3	1. 7.	8	2. 7.
4	1. 8.	9	2. 8.
5	1. 9.	0	2. 9.



The Accompanying Photographs Show Some of the Excellent Features of Mr. Everett Leo Deeter's Home Laboratory. Mr. Deeter has Built Practically All of His Apparatus, Which Includes Some Real Ambitious Electrical Apparatus. Among Other Things, There Is a Battleship Controlled by Wireless, a Large Electric Furnace, Long-Wave Tuning Apparatus, and High-Frequency Coils, Etc.

Special Laboratory Contest

Prize Winner--EVERETT LEO DEETER

THE accompanying photos are views of my Electrical Laboratory, which is the accomplishment of "odd moments" found in the past two years.

My wireless set is all home-made except for the Electro loose-coupler and the Murdock 'phones. The sending outfit is composed of ½ K. W. closed core transformer, glass plate condenser, two-winding oscillation transformers of my own design, large quenched gap, and also a small one.

The receiving set consists of an Electro loose-coupler of 2,500 meters wave length, cabinet loose-coupler used for long wave lengths, and three undampt wave loading coils. I have two variable condensers, and three detectors, with detector and an Audiotron bulb detector, which can be used as an amplifier for the mineral detectors. A ten-foot gas pipe driven in damp ground makes up the ground, and the aerial consists of three No. 8 copper wires, spaced on eight-foot spreaders, 100 feet long, and supported at one end by a 65-foot iron pipe mast, and at the other end by wooden pole, mounted on top of the laboratory, reaching a height of 45 feet. My antenna switch is a bridge type recently described in the *Radio Amateur News.*

The switchboard contains switches for operating various lights and circuits in the "Lab." The rheostat underneath panel, is used in connection with the large electric furnace shown in another photo. The high-frequency Oudin coil is capable of producing a heavy eight-inch spark when used with the ½ K. W. transformer and condenser. I operate several models by wireless, including a miniature battleship and a small electric car.

The large cabinet type Cabot-Holtz static machine is a 30-inch spark generator, with which many interesting experiments can be carried out. The views only show one room of my "Lab," there being another in which there can be found the usual tools, "junk," etc.

I have been a reader of the ELECTRICAL EXPERIMENTER for several years, and it was thru this splendid magazine that I received my start in my electrical career, and which said career I am preparing to follow. I am a Senior in the High School, and will enter college next year, to take a course in electrical engineering.

SPECIAL LABORATORY PRIZE CONTEST.

As announced some months ago, we stated that for special experimental laboratory photos and descriptions an extra inducement or special prize would be offered. This month, we have pleasure in presenting an exceptionally fine experimental laboratory group, that of Mr. Everett Leo Deeter. We hope to receive more of these complete laboratory write-ups every month, and shall offer a cash prize of $10.00 for the best description, accompanied by photos, submitted.

Send photos and descriptions to Editor of "Special Laboratory Prize Contest."

WITH the AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $5.00 PRIZE WINNER—

W. ROBERT DRESSER

HEREWITH I present several photographs of my laboratory and radio set. The electrical corner of my "Lab." contains two switchboards,—the large one at the right giving any voltage up to 110 by use of the step-down transformer and water rheostat. The lefthand switchboard gives 0-15 volts direct current. This board also contains my test meters and storage battery control. Practically every experiment may be conducted in this corner of the room, and it is here that I have constructed most of my apparatus.

My electrical equipment also contains several electric motors, spark coils, generators, Geissler tubes, high frequency coils, a gasoline and a steam engine. At present, I have under construction a small Tungar rectifier, described in a recent issue of the ELECTRICAL EXPERIMENTER.

For the purpose of surprising uninvited visitors who are willing to risk their lives by entering my laboratory, I employ an old automobile spark coil which has no vibrator, but which runs on the 60 cycle current.

Inasmuch as I have only been interested in chemistry for a short time, I have not as yet a very large variety of chemicals in my possession, but even with the small outfit I have, I am able to carry on a great number of experiments.

To aid me in experimental construction work, I have a bench lathe and a scroll saw, also a fairly large number of tools.

As for reading matter, I have on file the ELECTRICAL EXPERIMENTER, *Radio Amateur News* and many other leading radio and electrical magazines. My book department also contains: Hawkins' Electrical Guides, a set of the American School of Correspondence's Text Books, Volumes 1, 2, 3 of *Everyday Engineering* and several other books on radio and electricity.

In my wireless set, I utilize an Audion detector and also a Crystaloi. My set also comprises a large and a small tuning coil, a loose-coupler, two pairs of "Electro" phones and Tresco variables, a galena and a silicon detector, and a Radiotone test buzzer.

My sending set is a combined set using either a two-inch coil or a quarter-inch spark coil. The helix and condenser are of my own make. My main aerial is made of four wires, 100 feet long and I also have a four foot square loop aerial. I can utilize either aerial, merely by pressing one of the switches seen on the switchboard at the rear.

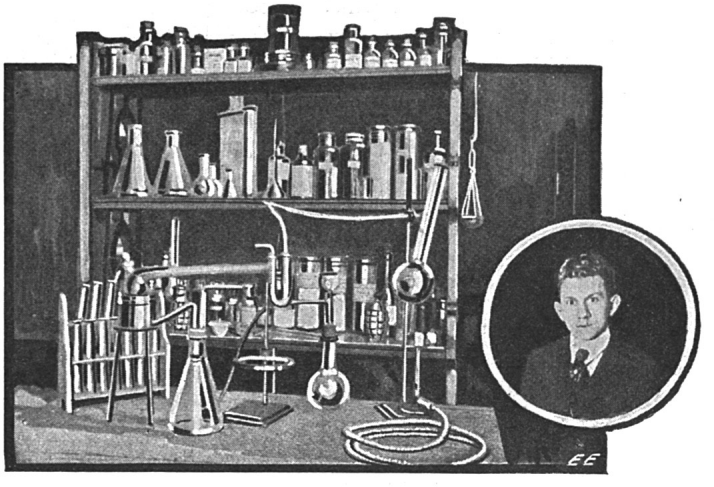
I hope to finish the long wave loader which I am now busily engaged in building, and then I shall endeavor to do much better work. My official call is 1-V.T.—W. Robert Dresser, 283 Main Street, Calais, Maine.

HONORABLE MENTION—H. DUSHER

$2.00 PRIZE

THE accompanying photo is one of my chemical laboratory which consists of over 150 chemicals and about as many solutions. My glassware consists of Erlenmeyer and Florence flasks, beakers, graduates, retorts, evaporating dishes, etc. I also own about 75 scientific books, and have on hand at all times a few of the latest copies of the ELECTRICAL EXPERIMENTER, *Popular Science*, etc. I also have several books on the art of fingerprinting, which I have spent considerable time in studying.

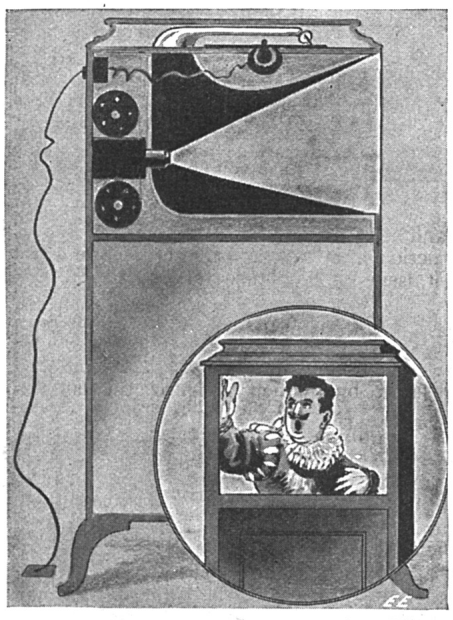
I have my stock of chemicals carefully arranged, and the bottles well labeled, so that no mistake can be made in mixing chemicals, certain of which are liable to cause an explosion or other serious trouble. I have a neat test-tube rack in which a series of test-tubes could be placed while making certain tests, and also the rack serves as a first class support for them when they are not in use. I also have a Bunsen gas burner together with an iron ring stand and tripod for supporting a retort or condenser.—H. Dusher, 364 East 123rd Street, New York City.



What To Invent

By JAY G. HOBSON

SOME day every talking machine will be known as "Phono-Movies" because a needed invention of this kind will enable the public to both *see* and *hear* their favorite opera, artist, band or orchestra in their own home by a simple electrical arrangement between the phonograph and the motion picture; possibly an arrangement similar to the one illustrated in the form of an electric harmonizer that will *simultaneously* reproduce the voice and picture of the artist singing. This will become practical when the inventor succeeds in obtaining the required co-operation between vibration that gives tone from the record and light or sight that produces motion pictures.



Why Not Motion Pictures With Our Phonograph Music? Some One's Going to Make a Fortune Out of Such an Invention.

It is true many attempts have been made to combine the motion picture machine and the phonograph but so far it has failed to work properly. In the recent past a youthful inventor perfected a machine to send pictures of people over the telegraph wire, and it seems to me a readjustment of this principle applied to the motion picture and the phonograph may prove to be successful in perfecting "Phono-Movies" for the home. A world market is waiting for this great instrument, and it is well worth an inventor's time and efforts to accomplish the task of successfully combining the two instruments.

SAW-DUST PAVING BLOCKS.

By the test of time, paving contractors know that wood blocks dipt in oil or creosote make the best and noiseless paving material obtainable. But at present these wooden bricks are sawed from sound timber which means large waste of valuable lumber that could be used for building purposes. All sawmills, woodworking plants and factories using lumber have an abundance of sawdust that is piled onto a dump to rot, blow away or be burned later if necessary. This is a useless waste of a valuable by-product that can be manufactured into compact form and that will be in immense demand for paving streets, etc. I believe a mixture of sawdust, asphalt or oil comprest in a powerful hydraulic machine fitted with dies or moulds for making wooden paving blocks would turn out a product that would be entirely satisfactory for use as street material. No doubt one similar to that shown in the sketch could be constructed to do the work properly.

ALL-STAR TOOTHBRUSH.

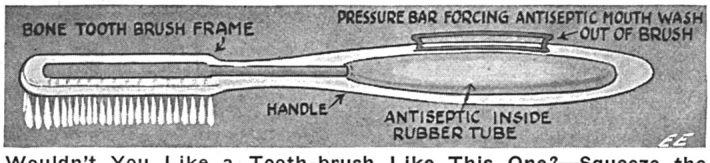
The Patent Office, from time to time, has allowed several patents on the toothbrush in different forms, such as the rotary kind, folding, removable bristles, etc., but so far as I am able to ascertain no one has as yet brought out a combination toothbrush and antiseptic mouth wash retainer.

The public have been so well educated on antiseptics for the mouth and tooth paste or powder for the teeth that ninety per cent of us use both. It seems unnecessary to have two packages or containers for the preparations, so the idea occurred to me that a *fountain toothbrush* would be a good improvement. The user could either carry the antiseptic liquid in the brush or use the fountain construction for water when washing the teeth.

In operation the handle of the brush is gript tightly which pushes pressure bar inward onto rubber tube and this pressure forces the antiseptic or water out thru the bristles onto the teeth which supplies a fresh quantity for each wash, instead of dipping the brush into a glass of water and using the same water or preparation over again as many of us are wont to do. As can be plainly seen this idea would be far more sanitary than the present method employed.

"AUTOMATIC MEMORY" FOR CONDUCTORS.

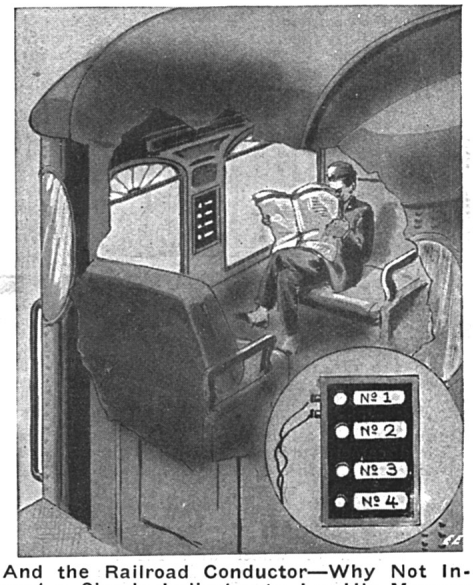
Did you ever stop to consider what a wonderful memory railroad conductors must have to remember the faces of their passengers, whether or not they have paid their fare, where they wish to get off and the numerous other things a conductor must *not* forget, to be 100 per cent efficient?



Wouldn't You Like a Tooth-brush Like This One?—Squeeze the Handle and—Presto! You Have the Mouth-wash Post-Instanter.

The truth of the matter is conductors do forget, pass by many a passenger's fare, carry passengers beyond their destinations, et cetera, because it is practically impossible for one mind to retain every detail when traffic conditions happen to be heavy.

The system now in use for assisting the conductor's memory is a small cardboard marker which he punches and sticks in your hat or onto the window blind to remind him of the station you want to get off. But frequently this piece of unsightly paper blows out the window, which confuses the conductor or else he forgets it, and you parade uptown with it showing like a headlight on the front of your hat.



And the Railroad Conductor—Why Not Invent a Simple Indicator to Jog His Memory as to Where Each Passenger Is to Get Off?

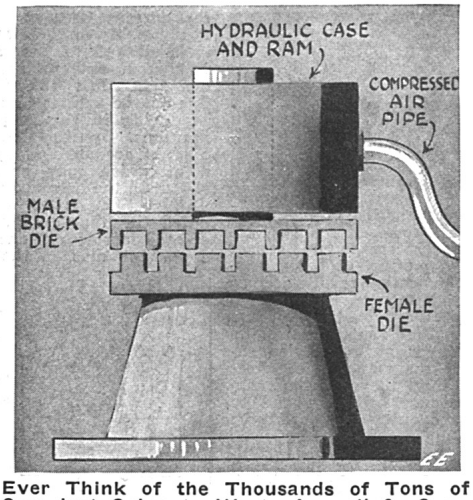
Most all trains are now electric lighted which brings to mind a possible device for marking the passengers of each seat. A small box-like construction with press buttons for operating it and at least four openings as shown for placing the numbers for the occupants of each seat, or the two seats thrown together for accommodating four people.

As the conductor collects the tickets, he presses the button that will set, by electricity, the number of the station the particular passenger wishes to get off. A small light, inside the box, enables him to read the numbers from the aisle as he passes, which will keep him posted on the destination of each person and will greatly relieve his memory which must work overtime because of the inefficient system now in use.

Once the push button was deprest and the number desired set, passengers could not change it because of a lock arrangement enclosed that held the number permanent until the conductor prest his key into the lock which would release the button, the numbers and shut off the light.

There is no question at all but the railroads would gladly adopt a system of this kind, and it is needless to say the inventor would reap a handsome reward for his improvement if it could be built cheap and simple.

This is indeed, a much needed device, and its utilization would tend to save time and trouble for both the conductors and passengers, and would also undoubtedly eliminate many unnecessary misunderstandings as to the distance the passenger is entitled to travel. Any person would prefer to travel on a railroad upon which the conductors were not compelled to annoy the passengers at each station for the purpose of punching their tickets, and it is evident it would be to great advantage for the traction companies.



Ever Think of the Thousands of Tons of Saw-dust Going to Waste Annually? Compress It Into Briquettes and Pave the Streets With Saw-dust! Sounds Foolish? But We're Coming to It.

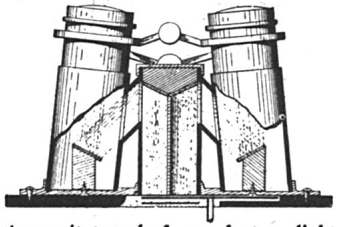
(Copyright 1920 by the Author)

LATEST PATENTS

Cinematographic Stereoscope.

(No. 1,334,480, issued to Harry R. Zimmer.)

This scheme is the very latest for production of stereoscopic movies and uses two telescopic tubes fitted with regular stereoscopic lenses as its basic principle. Light is transmitted thru the lens onto a reflector

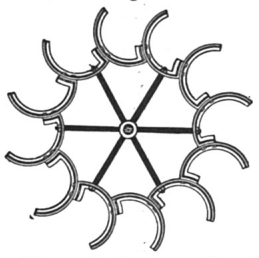


thence it travels forward at a slight angle and is again reflected inward, having effect upon the film. The other lens adjusted to it presents another view of the object, but due to the difference of refraction between the lenses, the two images upon the film will be slightly different. The rotary shutter revolves in the interval between the lenses and camera proper, shown in our illustration with the shaft extending.

Horizontal Windmill.

(No. 1,334,882, issued to John F. Boettner.)

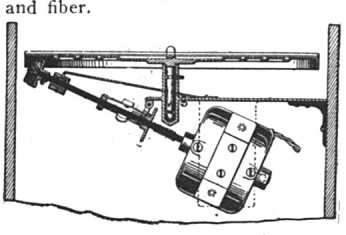
A form of wheel with radially disposed plates mounted on the spokes and connected to each other in circular series. The plates are shaped so that the wind will strike them regardless of the direction in which it is blowing. The more specific object of the invention is to apply a method for maintaining the circular series of plates by pressing those plates compactly, simply and efficiently, at a low cost. The plates themselves are reënforced circularly by angle irons, which make for ruggedness and lightness.



Phonograph Driving Machine.

(No. 1,335,809, issued to Dexter W. Allis.)

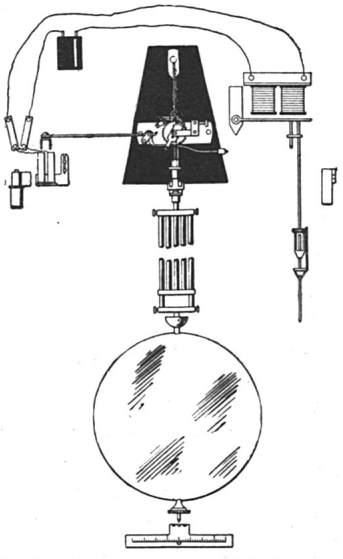
An exceptionally clever and novel scheme is the subject of this recent patent. The phonographic table itself does not have the delicate bearing mechanisms which have been so essential in the past, but a single ball is used as our illustration shows. To this turn-table directly coupled thru friction is a motor driven by the regular house current. The shaft leading from the motor to the friction disc at its end has a universal joint upon it which is, nevertheless, so adjusted that the motor could run considerably faster than the shaft itself. A fly-ball governor maintains the even speed. Art gum is used as a friction wheel, giving a positive non-slipping drive, at all times resilient and absolutely noiseless, differing greatly in this respect from rubber and fiber.



Electric Clock.

(No. 1,335,147, issued to Poul Peter Anderson.)

An exceptionally clever scheme whereby a master clock is caused to keep its pendulum oscillating by a rather odd feature. The method employed is as follows. As the pendulum swings from side to side, it engages with a ratchet wheel. This ratchet wheel is actuated by a ratchet on the pendulum and turns slowly, one notch with each oscillation. A trip is fastened to this wheel which automatically closes a circuit thru a lever arm momentarily, by introducing a metallic connecter between two containers of mercury. Automatically, a circuit

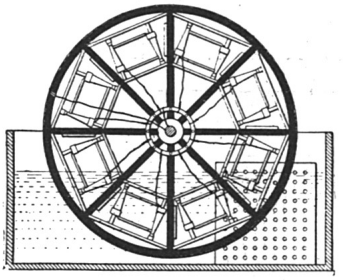


is closed to a magnet which lifts up a hammer-like device not shown in our demonstration, but as stated before, the circuit is of very short duration, and is again quickly broken whereupon this hammer device is released allowing it to strike an arm carried by the pendulum; the effect of which blow causes the oscillation to be continued.

Electrolytic Apparatus.

(No. 1,335,175, issued to Matthew M. Merritt.)

This is a very clever improvement in electrolytic apparatus and methods, and seems to embody a few radically novel ideas. A wheel

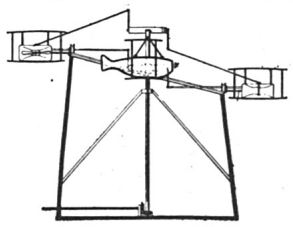


in which the members to be plated are fixt, is rotated between two anodes, preferably scraps of copper when copper plating is being performed. The cathodes themselves are connected to the hub of the wheel, i. e., the articles to be plated. Also a metallic rim around the wheel known as a "thief" is connected to the same hub. The effect being to take up the excess of copper which would formally tend to deposit on the outer portion of the cathodes. Another novel feature is the *plow*, a block of wood extending from each side of the wheel shakes. When the wheel is rotated the liquid is agitated enough to give an even coating. Each item is in the solution two seconds and out of the solution four seconds; which proportion has been found to be very satisfactory.

Amusement Apparatus.

(No. 1,337,820, issued to James H. Butcher.)

This amusement apparatus embodies general principles of opera-

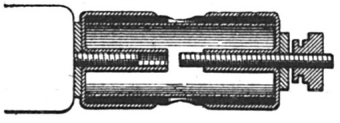


tion and movement of merry-go-rounds and allows a wide range of modification in the plan and general form of the track or similar guiding means so as to produce variety, necessary and desirable to the public. There is employed an elliptical form of track on an inclined plane. The airplanes are so arranged by means of lever system as to keep them on an even plane. A propeller at the front is rotated by the means of gearing thru the wheel resting upon the track.

Intensifier for Spark-Plugs.

(No. 1,335,940, issued to J. A. De-Vinoiss and H. L. Miller.)

This invention relates to intensifiers for spark-plugs for internal combustion engines. It is simply an auxiliary gap which can be placed on the top of the spark-plug and can be held in that position where it is not subject to vibration when

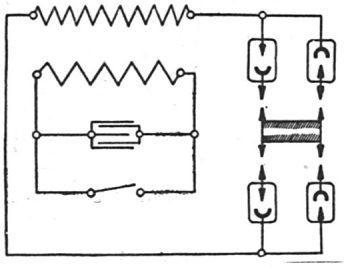


the engine is in operation. It has an adjustable screw at the top by means of which the gap can readily be lengthened. This gap is between the spark-plug screw top and the movable electrode. A window on each side permits of vision and a mica shield prevents oil and other dirt from accumulating between the gaps.

Ignition Apparatus.

(No. 1,335,933, issued to Jacques Bohli.)

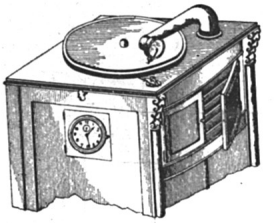
This planned device is for the distribution of high voltage current for ignition apparatus, for internal combustion engines; and has for a two-cylinder motor, two rectifying devices. The inventor claims that the current used in motor ignition is invariably of the alternating type; it is allowed to pass thru one rectifier and current in the opposite direction thru the other rectifier due to the actions of said rectifiers, producing in this way intermittent ignitions. Ignitions in four-cylinder engines are effected by an arrangement which may be employed as shown in the accompanying diagram. The rectifier tubes will be readily noted in the drawing, having a pointed arrow on one side and a cup shape disc on the other.



Time Control for Phonographs.

(No. 1,337,759, issued to August C. Dittrich.)

In the last issue we described a time control for phonographs. Mr. Dittrich has secured a patent on the device then described and also on the one here described. A clock mechanism is fitted like a door into the cabinet in such a manner that the simple shutting of the door when properly arranged will set the apparatus. A record is placed upon the machine and it is then ready to "wake you on the morrow." Instead of being rudely awakened by an ordinary terrifying alarm, your favorite musical selection will awaken you. All that is necessary is a separate catch and a detent trip which, when set, holds the starting mechanism inoperative. This spring is released by the clock, and that in turn releases the catch and allows the turn-table of the phonograph to revolve. It can be instantly detached and the hand control used if that method is desired for playing ordinarily. An-

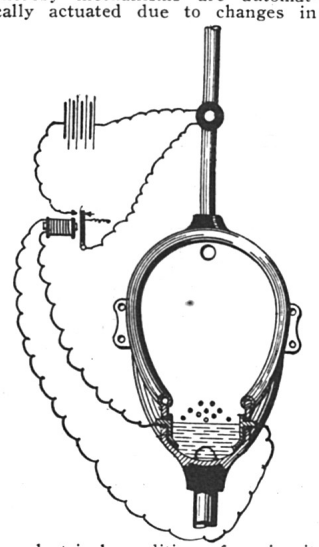


other type is made so that it can be attached directly to any phonograph and no change in the latter case is necessary; the apparatus being self-contained in the clock mechanism, and simply set upon the machine.

Automatic Actuation of Mechanisms.

(No. 1,335,380, issued to Edgar E. Littlefield.)

This is a rather clever invention whereby mechanisms are automatically actuated due to changes in



the electrical condition of a circuit caused by varying the character or condition of a bath which forms a link in said circuit. It has been found that the difference in electric condition caused by slight changes in the electrolyte either of chemical or thermal character, may be used to operate a relay and hence the scheme has been applied to closets, etc., which flush automatically due to the thermal or chemical changes when any body waste is added thereto. It consists of two electrodes placed in the closet and insulated from each other. These are connected to a relay, with a battery in series, which relay in turn is connected to any other mechanism for flushing purposes, etc.

Scientific Humor

And Exploded with Wrath!—FRESHMAN—"I broke two beakers in yesterday's laboratory experiment."

SOPH.—"What did the professor say?"

FRESHMAN—"He made a *retort.*"—*Edward J. Norwood.*

Yes, With the Gas-Meter Off!

There is meter in poetry,
There is meter in tone;
But the best meter of all
Is to meter alone!

—*Edward Lippert.*

Safety First.—AUTO SALESMAN (demonstrating new car to a lady)—"You had better not touch that spark-plug. It will shock you."

LADY—"Then I guess you had better put shock-absorbers on my car!"—*Dulaney M. Gregory.*

Soft Water Must Be Fog!—PROF. WATT T. ELL—"The class in chemistry will now come to attention. What is the formula for gasoline?"

DUMAS ENNITHINGG (star pupil)—"H O N C—H O N C."

PROFESSOR—"Very good, now the formula for sea water?"

PUPIL—"$C\ H_2\ O$, is that right, teacher?"

PROFESSOR—"We'll let it go at that. What is hard water?"

PUPIL—"It's ice, sir."—*J. H. Schalek.*

With a Lightning Arrester!—"I want a man to figure out how much electricity it is going to take, to run my mill."

"One of those lightning calculators, I suppose."—*Barney Kellam.*

Telegraphy Explained.—"Pap," said a colored youth, "Ah'd like you-all to expatiate on de way dat de telegraph works."

"Dat's easy 'nuf, Rastus," said the old man. "Hit am like dis: Ef dere was a dawg big 'nuf so his head could be in Bosting an' his tail in New Yo'k, den ef you tromp on his tail in New Yo'k he'd bark in Bosting. Understan', Rastus?"

"Yessah! But how am de wireless telegraph?"

For a moment the old man was stumped. Then he answered easily: "Jess prezactly de same, Rastus, wid de exception dat de dawg am 'maginary."—*Everett Cookson.*

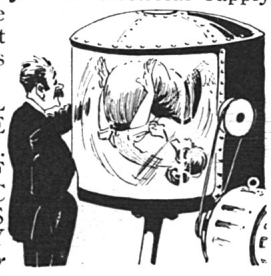
And in Winter We're *Short* of Coal.—TEACHER—"By accurate experiments, we have come to the conclusion that *heat* expands a substance, while *cold* contracts it. In other words, *heat* makes a substance *longer;* cold makes it *shorter.* Now, who will give me a definite example of this?"

STUDENT—"Here is one. In summer it is *hot* and the days are *longer.* In *winter,* when it is *cold,* the days are *shorter.*—*Nathan Silverman.*

FIRST PRIZE $3.00

The Easier Way.—An electrical supply merchant hung the following sign out in front of his shop:

"DON'T KILL YOUR WIFE WITH WORK. LET ONE OF OUR ELECTRIC DISHWASHERS DO THE DIRTY WORK." — *Oscar DuPre.*



That's What Makes 'Em Afraid?—There is no reason why people should not take more to flying because when they are in the air their fears are groundless.—*Earl H. Barton.*

AS our readers will note our new department keeps on improving. Quite a few jokes have been hatched out successfully this month and are crowing lustily—until somebody writes us a sassy letter, telling us that his grandfather related the joke to him years ago. Of course, we cannot know every joke that ever was fostered upon a suffering humanity,—we aren't that old—and what looks new to us might belong to the pliocene age. Nevertheless, we believe you will like the present efforts of our jokesmiths at one dollar a crow.

One of the latest developments is that readers keep on sending us scientific jokes which have appeared in Volume No. 1, ELECTRICAL EXPERIMENTER, *and expect to be paid for them. We are not quite convinced that they are sending these jokes in as real jokes or whether they intend to play a joke on us with those jokes. In either event it would be a poor joke. In the meanwhile, we are paying* $3.00 *as a first prize for the best, strictly fresh laid joke and* $1.00 *for each medium-boiled one.*

Why Not Print 'Em on Fly Paper?—"Don't you think that we should have a more elastic currency?" askt the old fogey.

"It's elastic enough," replied the grumbler. "Why don't they make it more adhesive?"—*Leo Hansen.*

A New Use for Fifi.—A lady who kept a little curly poodle lost her pet, and called on the police to find it. The next day one of the force came around with the dog, very wet and dirty. The lady was overjoyed, and asked a number of silly question—among others:

"Where did you find my sweet, dear little darling?"

"Why, ma'am," said the officer, "a fellow had him tied to a pole and was washing windows with him!"—*Charles Dill.*

Current Topics.—FIRST ELECTRICAL ENGINEER—"Wire you insulate?"

SECOND ELECTRICAL ENGINEER—"Couldn't get ohm sooner."

FIRST E. E.—"Watt?"

SECOND E. E.—"I was out sparking in the park."

FIRST E. E.—"I can guess switch girl, Mazda?"

SECOND E. E.—"See here, fuse get personal I'll socket to you!"—*Edwin S. Warner.*

Did the Mosquitos Give Honey?—CRANK—"What's in those cages, Hank?"

HANK—"I'm trying the Luther Burbank stuff on insects. You know that wizard crost two spiny cactuses and produced a *spineless* cactus. I'm trying to cross a bee which stings from one end, with a mosquito which uses the other end."

Two weeks later Crank met Hank. "Well, Hank, how did you make out?"

Hank, swathed in bandages, mumbled: "Rotten. I produced bees which sting at *both ends.*"—*J. H. Kraus.*

The Messenger Got "Shoed!"—"Here, lad, take these papers up to the blacksmith."

"Do you want them forged?"

"No, just filed."—*H. Howey.*

Too "Deep" for Grandpa.—"Grandpa, have you heard of this new underground wireless?"

"No, son; what is it? A new method for communicating with the dead?"—*D. Kantro.*

We Just *Had* to Accept This One!—JACK—"Why do you always sign your name William Johnson E.E.?"

WILL—"Because I have earned that degree."

JACK—"Oh! Then you are an Electrical Engineer?"

WILL—"Oh! No! I am an Electrical Experimenter."—*Edward L. Friedman.*

An Ingersoll Might!—"Did your watch stop when it dropt on the floor?" askt the man of his friend.

"Sure," was the answer. "Did you think it would go thru it?"—*C. S. Harvey.*

Hope He Don't "Short-Circuit!"—HE—"Here comes a friend of mine. He's a human dynamo."

SHE—"Really?"

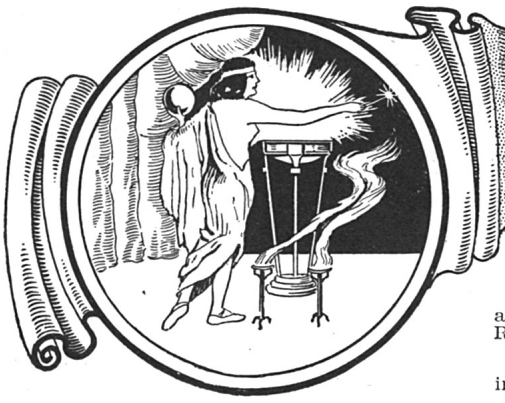
HE—"Yes, everything he has on is charged."—*J. O. Campbell.*

Unless It Hits Your Barn.—TEACHER—"What is the difference between electricity and lightning?"

WILLIE—"You don't have to pay for lightning."—*Wade D. Annis.*

She Must Be to the Point!—WAG—"What makes the best contact points?"

TAG—"My girl's lips, of course!"—*M. M. Wrenn.*



THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

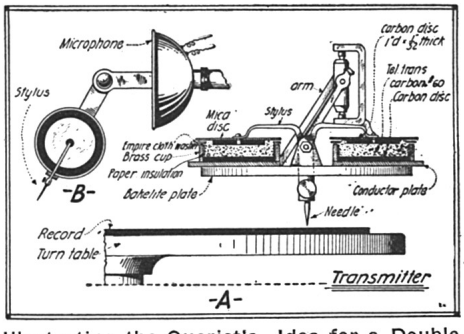
PHONOGRAPHIC TELEPHONE TROUBLES.

(1051) E. A. Papini, Philadelphia, Pa., writes this department:

Q. 1. In the enclosed sketch is shown an arrangement for loud-speaking telephones with which I have been experimenting with, but with poor success. Evidently something must be wrong. The transmitter is, perhaps, not proportioned properly, but when connected to a common telephone receiver the degree of loudness or volume is fair, but there is present considerable extraneous noise. When it is connected to the receiver shown in diagram, the result is very poor, resulting in the degree of loudness being weakened and also the extraneous noise is increased; perhaps the design shown is wrong or again the elements involved may be out of proportion. Kindly advise if you can give a better way to design and proportion these parts.

A. 1. We have studied your diagrams and circuit for the phonographic telephone arrangement carefully, and tho they would, off hand, appear to be quite workable, our experience with apparatus of a similar nature, as well as the study of telephone matters in general and especially some recent developments in this direction, tend to make us think otherwise. In the first place, the editor of this column does not believe in a phonograph transmitter or microphone in which the needle or stylus arm is mechanical or rigidly connected to the movable electrode or electrodes of the microphones, as shown in your sketch, altho many devices of this type have proven more or less successful.

One of the best ways to convert phonographic music into telephonic current waves would seem to be that followed by the Magnavox designers, and this method is shown in the diagram at "B." Here a special tone-arm is used, and the diafram



Illustrating the Querist's Idea for a Double-acting Microphone to Be Actuated By the Stylus of a Phonograph; and At B, the Method of Mounting the Microphone Directly In the Tone Arm As Suggested By the Magnavox Design of Phonographic Telephone

of the phonographic reproducer is not tampered with or loaded down with extra weights or levers for actuating microphones, but is left free to vibrate at its own frequency or imprest frequency. This seems very good practise, as it is not well to tamper or put an extra load on the diafram of a phonograph sound box, for the reason that the designers of such machines today have ascertained to a very fine degree just the right proportions for this mechanism. You might also study Mr. Gernsback's

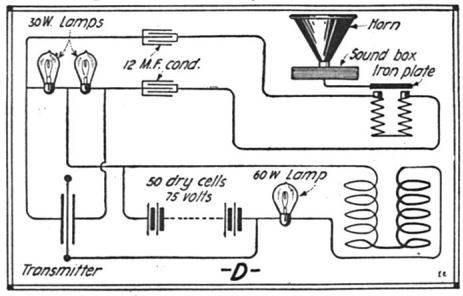


Diagram Used By the Querist In Connection With His Loud-talking Telephone Transmitter Shown At A, and the Reproducer Shown At C, and Which Has Not Given Him the Results He Originally Anticipated. The Faults Of This Arrangement Are Here Gone Into.

WANTED!!!

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Here's what we want! What have you got?

ELECTRICAL PHOTOS—
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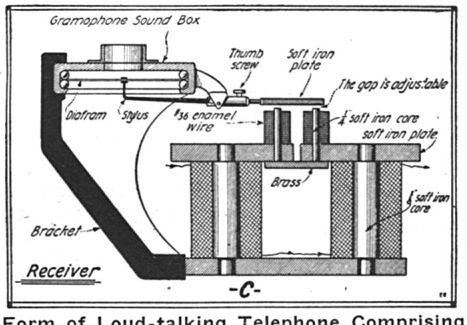
Address photos to—Editor "Odd Photos", Electrical Experimenter, 233 Fulton Street, New York City.

Physiophone in our April, 1920, issue. He developt a simple and efficient phonograph microphone, which works remarkably well. Referring to Fig. "B" again, we see that the sound as reproduced by the sound-box travels up thru the tone arm for a distance of about four to five inches, when it impinges against the diafram of a microphone of standard pattern, which forms an integral part of the tone-arm.

It would seem to us that, with the arrangement shown at "B," that more powerful effects could be obtained with regard to the transfer of sound to the microphone, but where the sound is desired to be picked up by the microphone in a fully resonant form it is usually the best practise to place one or more microphones in the wooden horn or amplifier chamber of the phonograph. This is so, for the reason that only when the music has reached the outer end of the amplifying chamber has it fully expanded in all of the harmonics of the notes. Therefore, the music in figure "B" would seem to be more strained and forced, altho perhaps more powerful, but in the end very "hard", so to speak, compared to the case where the microphones are placed in the amplifying chamber.

With regard to the receiver you show at Fig. "C", we do not care very much for this design, and we can truthfully say from our experience in the matter and the experience of other investigators, with which we are familiar, that many thousands of dollars have been expended and also many years of research on the telephone receiver as we know it today, and it is a very peculiar fact that not a single different type of receiver, out of the thousands of types that have been developt, has ever been adopted or recognized by the telephone world that has not embodied the general basic principles laid down by Prof. Bell.

In the loud-talking receivers as well as



Form of Loud-talking Telephone Comprising a Phonograph Sound-Box Rigged Up to Be Operated By a Pair Of Electro-magnets In the Manner Apparent. The Merits and Demerits of This Interesting Scheme Are Here Discust.

in telephone receivers of different makes, all of which practically embody the same principle, the main feature is the circular *iron diafram*. There are not more than three or four telephonic receivers on the market which do not use a diafram, and

(*Continued on page* 308)

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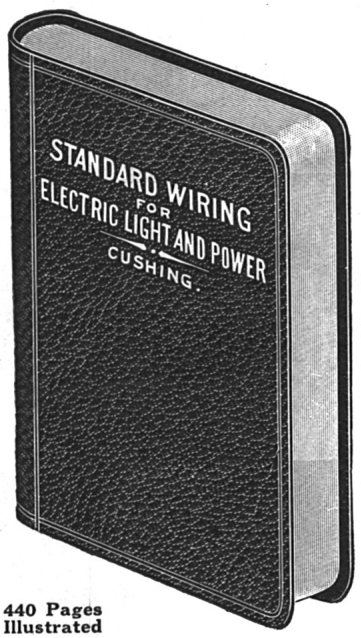

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"The Oracle"

(*Continued from page* 306)

they are so expensive and complicated that it is seldom that they are employed, excepting for very special requirements.

The Magnavox, most powerful telephonic loud talker ever produced, the voice of which has been hurled thru the air for a distance of over a mile, employs a thin circular diafram and not a heavy armature of the general arrangement you show. The trouble with your arrangement is primarily that it has too much inertia usually, and it cannot follow the rapid fluctuations of telephonic speech or currents, the average frequency of which is 800 cycles per second. The Magnavox loud-talker has a large diafram in the center of which a small, light weight, air core magnet coil is secured. This coil moves at right angles thru a gap between the pole-pieces of a powerful electromagnet. The talking current is past thru the coil mounted on the diafram.

We would suggest in general that you will get much better results so far as the receiving end of your circuit is concerned, unless you build a very large elaborate and extremely well designed mechanism, by using a diafram with suitable electro-magnets to operate it, instead of the arrangement shown at Fig. "C". We hope to publish more details of the Magnavox system in an early issue. In the November, 1919, issue considerable data was presented with a cross-sectional view of the Magnavox loud-talker.

Home Electrics

By G. L. HOADLEY, M.E.

(*Continued from page* 274)

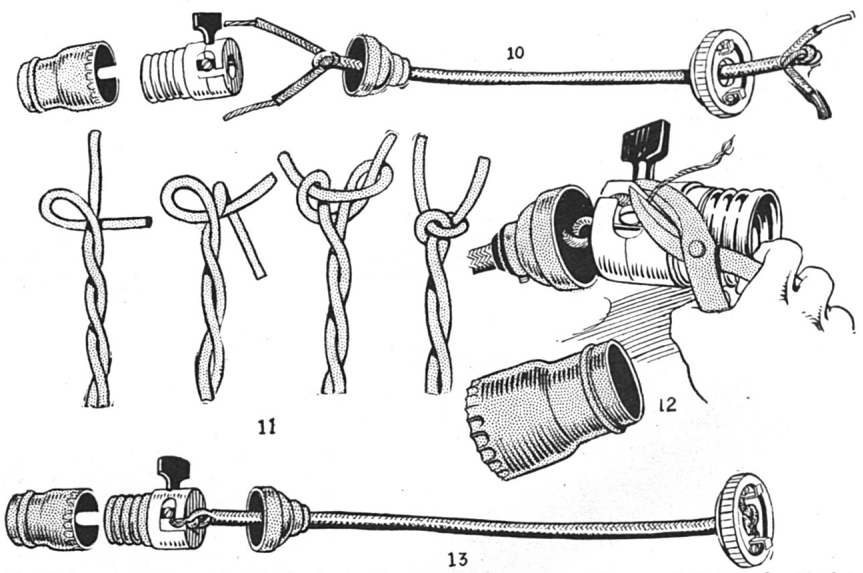
socket shells. Fig. 4 shows the Interchangeable socket, which will snap together and hold securely in any position without turning. Fig. 5 will snap together and hold in twenty different positions. It is known as the Multipo type and is quite generally used.

A portable lamp guard with a reflector as shown in Fig. 6 is desirable but not a necessity. The difference between ordinary lamp cord and re-enforced flexible cord is clearly shown in Fig. 7 and Fig. 8. The New Code lamp cord Type C has a 3/64-inch rubber insulation placed over a tight close wind of cotton and over all is the usual cotton outer braid. The re-enforced flexible cord Type PO has an additional rubber jacket which in turn has a hard glazed-cotton braid covering it.

To connect up the extension cord at the socket end, take a sharp knife and "skin" the wire as one would sharpen a lead pencil. See method B, Fig. 9. If method A is used, the wire is apt to be nicked and will be easily broken afterward. Bare the wire for about 2 inches, scrape the exposed strands with the back of a knife till they are bright, and then twist them together. The outer braid and the adjoining rubber jacket should be cut away a sufficient distance to enable the two rubber-covered separated inside wires to reach each connection on the lamp socket, but the braided and rounded cord should be left intact where it passes thru the cap. The socket cap should then be slipt back over the cord to the position shown in Fig. 10. Fixture sockets have a threaded hole at the smaller end with a set screw at the side to fasten the socket on the metal fixture. Such sockets should have the set screw loosened and a rubber bushing screwed into the smaller end of the socket to prevent chafing the flexible cord.

Next, tie a knot with the two insulated cords as in Fig. 11 to take the strain off the screw connections when the cord gets pulled or jerked as it will in actual service. Care should be taken to see that the insulation on the separated wires is intact where the knot is made or the bare wires would be in contact and trouble result. The knot itself is not difficult to tie if it is started right. Remember to place the first fold *behind* the straight wire; the rest of the operation is easy and clearly shown in Fig. 11 which illustrates the tying of the Underwriters' Knot.

Next, loosen the two screws in the socket base and bend each bared copper wire *once* around the screw in the direction in which the screw *tightens*. Draw the wire up tight under the screw as shown in Fig. 12. The spare ends will give the fingers a hold and assist in getting the wires tight under the screws. Now tighten the screws and cut off the spare ends as shown in Fig. 13. Now slip the socket shell and cap back over the socket base and snap them together, thus completing the operation.



10. Extension Lamp Cord Ready to Assemble. 11. Four Stages of Tying the Underwriter's Knot in Lamp Cord, to Take the Strain from the Connections. 12. Clipping Off the Projecting Wire on a Socket Connection. 13. The Connected Extension Cord, All Joints Tightened Up and Ready to Assemble the Socket. The Porcelain Rosette Twists Into Place On Its Base.

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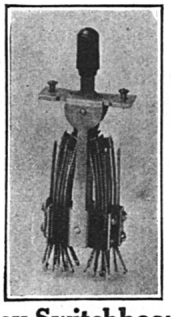
½ to 2 mf..... .60c



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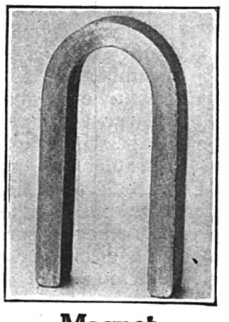

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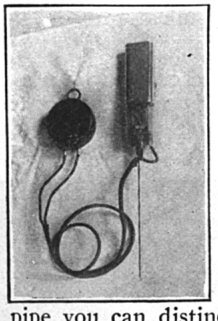

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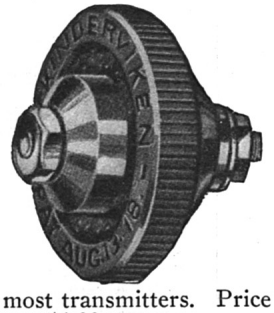

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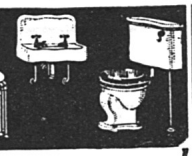

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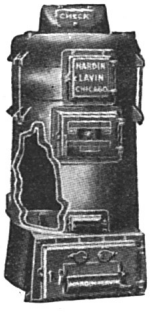

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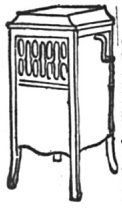

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Do We "See" Electrically?

By H. WINFIELD SECOR

(*Continued from page* 264)

such a position as to affect the sight portion of the brain, then the function of sight would also be affected. The more one thinks about it, the more certain it seems that the

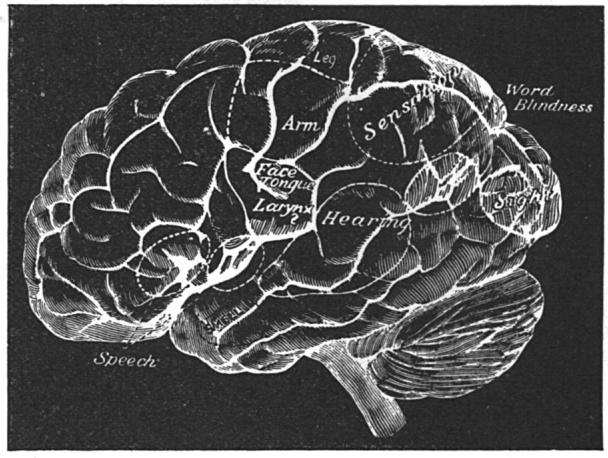

Fig. 2. The Cortical Brain Centers of the Various Functions. These Have Been Determined by the Fact That the Brain Cells in These Regions Sometimes Die, Due to an Injury, Paralyzing Speech or Sight, Et Cetera; or a Lesion in the Brain Produces Paralysis Externally.

whole action of sight is very much akin to that of the "telephot"—the man-made electrical eye, upon which many scientific investigators are now working, and which has been partially successful, so far as it has been developed.

As is well known, selenium or light-sensitive cells are used in this apparatus, and as the varying degrees of light and shade impinge on a series of these cells, a large number of which are sometimes arranged in a compact bank, the individual cells lower their electrical resistance in accordance with the amount of light thrown upon them. Conjointly, the various circuits to which they are connected have their currents altered correspondingly. The relays or other apparatus at the receiving end of the circuit respond in accordance with the various light images thrown on the respective cells at the transmitting end, and with suitable current responsive and light-reproducing apparatus at the *receptor*—we have once more the picture seen at the transmitting end thrown up before us.

It is the old, old story of nature's great simplicity. Man finds it very hard to imitate nature and there are some things in which nature has outdistanced him forever. The 20th century has seen greater and more epochal advances in science than all of the centuries that went before, but as yet no one has succeeded in reproducing the action of sight or "television" over an electric wire in a satisfactory manner—nor anything like it!

Some of the inventors working on television have used several hundred light-sensitive cells or even a thousand or so, but it is readily seen that no very perfect picture or likeness could be transmitted over a wire in this manner when a single human eye and its attached optical nerve and brain center involve the use of somewhat

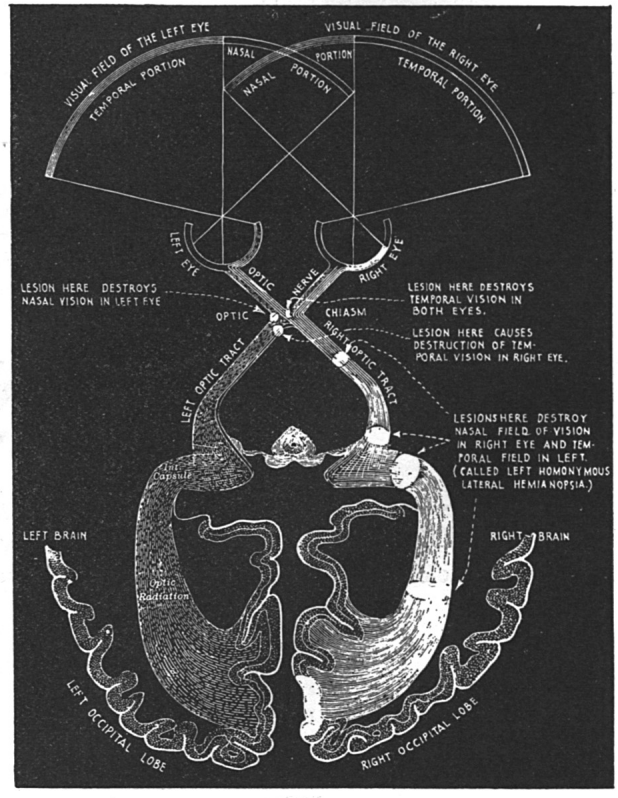

Fig. 3. A Remarkable Diagram Showing in Detail the Visual Fields of Both Eyes, and the Portion of the Retina Each Field Affects. The Location of Lesions and Their Effect Upon the Sight Is Clearly Shown. This Lesion Could Be a Blood Clot, Abscess, or Any Other Injury Which Would Destroy the Nerve Fibres in the Area Indicated.

over 2,000,000 light-sensitive elements!

Possibly, if we should build an electrical apparatus as elaborate as this, we could reproduce a very perfect image. But where is the genius who is going to build an optical or light-sensitive cell the size of the human eyeball or about one inch in diameter (the average diameter of the human eyeball) where, in the space of less than two square inches, there are encompast 2,000,000 light-sensitive cells? And to make television a perfected idea, it would seem that we should have an apparatus almost as small as this and nearly as sensitive with regard to the subdivision of the light image. The rod and cone layer covers about six-tenths of the inner surface of the eyeball.

The electrical theory of ocular vision in humans, as well as in animals, has been arrived at in several different ways. It may be thought that this is merely a hypothetical supposition, but such is not the case. This theory of ocular vision has occupied the writer's mind for a long time and it has been very difficult to procure much aid on the subject, as but a trifling amount of matter has appeared on the subject, owing principally to the fact that the function of sight is so involved and extremely delicate that it has, up until the present time, been almost impossible to determine just how we do *see.*

A medical friend of the writer's recently gave him a little data which only tended to more greatly strengthen the electrical

(*Continued on page* 313)

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Popular Astronomy

By ISABEL M. LEWIS, M.A.

(*Continued from page* 281)

stars in the system are flowing to and fro along the spiral arms in obedience to the dynamical laws of the system.

It is believed, moreover, that this system of stars may be surrounded by dark absorbing matter, such as appears in photographs of spiral nebulæ, which shuts off from our view external systems lying near the plane of the Milky Way.

On the assumption that the system of stars to which our sun belongs is a vast spiral nebulæ formation an attempt has been made to find its motion onward thru a still greater universe, that occupied by the spiral nebulæ, and a motion thru space of 375 *miles per second* has been deduced from rather limited data. This may be considered the first attempt to find the motion of our sidereal universe as a unit with reference to external universes, the spiral nebulæ.

We have come far in the past three hundred years from the conception of an immovable earth at the center of the universe to such an awe-inspiring conception as is now seriously entertained by the astronomers of today and which is based upon convincing observational evidence of the actual motions of the stars and spiral nebulæ obtained by means of the spectroscope.

Whatever may be discovered in the future in regard to the form and extent of the universe the idea of a fixt and immovable center either within the solar system or among the stars beyond has gone from the minds of men at last.

Not more than a generation ago a survival of the old idea of a fixt center was seen in the theory that Alcyone, in the Pleiades was a "central sun" about which all the stars revolved, but it is now known that the Pleiades form a moving star cluster. Alcyone is therefore drifting slowly onward thru the universe and the idea of a fixt and immovable center to which man may anchor his ideas is drifting away also. There may be local centers of systems, such, for instance, as the sun occupies in the solar system or some group of stars may occupy in the stellar system to which our sun belongs, yet *as a whole* these systems move on and their centers with them. There is no evidence today that any fixt and immovable point exists in the heavens.

No celestial object has been found to be without the attribute of *motion,* not only motion *onward* thru the universe, but also *rotational* motion about an axis of the body. The planets rotate on their axes as well as revolve about the sun, and the sun also turns on its axis as it moves onward thru space. This rotational motion is also found in the nebulæ and star clusters as well as in the stars and planets. No object in the heavens is known to be without it. Even the slowly drifting Orion nebula possesses a rapid internal velocity of rotation. There is no such thing as a body absolutely at rest in the universe.

TABLE I.

Showing the number and relative size, velocity and distribution of the various types of celestial objects.

Object	Number	Diameter	Velocities miles per sec.	Distribution
1. Solar System				
a. Planets	Eight	3,000 to 88,000 mi.	3 to 35 miles per sec.	Revolving in orbits about sun.
b. Sun		864,000 mi.	12½ mi.	Traveling thru galactic systems of stars (Milky Way).
2. Stars				
a. Helium (bluish)			8 mi.	
b. Hydrogen (white)	Approx. 2,000,000,000 (Two thousand million)	500,000 to 1,000,000 mi. on the average	14 mi.	All types of stars are more or less crowded toward plane of Milky Way in lens shaped formation. (Milky Way possibly a spiral nebula.)
c. Solar (yellow)			18-19 mi.	
d. Type M (red)	Including all types		21 mi.	
3. Nebulae				
a. Diffuse or Gaseous	Numerous	Very extensive, many light years.	Very low	In or close to Milky Way.
b. Spiral	Approx. 700,000 (Seven hundred thousand)	Size and distance doubtful but very great.	Average 480 mi.	Far external to Milky Way and numerous near its poles.
c. Planetary	One hundred and fifty (150)	Several times that of the solar system on the average.	Average 48 mi.	In or close to Milky Way.
4. Globular Star Clusters	Not over one hundred known	Many light years.	Very high	External to Milky Way and spherically distributed about it.
5. Magellanic Clouds	Two (Greater and Lesser)	" " "	Very high	Far beyond Milky Way. Possibly near by spiral nebulae.

Electricity from Water Power

By H. WINFIELD SECOR

(*Continued from page* 285)

proper dimensions of the buckets, the width of the wheel, etc.

Generally speaking, the head or drop of the water is most always known first, owing to natural conditions available. For a water-wheel the diameter of the wheel is generally found by subtracting two feet from the head, exprest in feet; while the width of the water-wheel will depend on several factors, which are the speed at which the wheel is to rotate, the amount of water to be carried over the wheel per minute, the shape and number of buckets, and also on the depth of the buckets.

The horsepower of an overshot water-wheel is calculated as follows: The head in feet, multiplied by the weight of water in pounds falling over the wheel per minute, divided by 33,000 times .7. The tables appended at the end of this article give a great deal of information on small water turbines which are available on the market, and if those interested will address the writer enclosing a stamped, self-addrest envelope, the names of companies manufacturing both small and large high efficiency turbine wheels, as well as the latest pattern steel water-wheels will be furnished gratis.

Do We "See" Electrically?

(*Continued from page* 310)

theory here presented. This data, in brief, was as follows, viz.: that in making tests on the action of light on the rod and cone layer of the eye, and also in attempting to make measurements of the velocity of transmission of the optic nerve impulses, that there are only two theories apparently open as to how the light images passing thru the lens and, falling on the retina, could produce their well-known effects on the cells of vision in the brain. Either the action is electrical or of the nature of a photo-electric effect; or otherwise it is considered that it is of a chemical nature,—*which* it is, however, is the moot question that remains as yet unanswered.

The 2,000,000-odd fibers composing the optic nerve and over which the light impulses, either electrical or chemical, but presumably and apparently *electrical,* are transmitted are of very small size—far smaller than one would imagine at first. These fibers, corresponding to minute electric wires, so far as we can now see, are only visible under the most powerful microscopes, such as those used by physicians and physiological investigators.

It has furthermore recently been pointed out by a European investigator that the nerves and nerve fibers are indeed like many electric wires, for several reasons,—principally because it has been found that these parts of the human body are covered thruout with a fatty insulating covering, and as this authority has suggested, it would seem to show that this insulated covering on the nerves and other component parts actually serve to preserve the electric potential and natural charge of the body; and in certain diseases that these break down, causing the electric charge of the body to become markedly lowered.

As this investigator states further: "Anything which causes a break in the insulated covering of the body or its component parts, such as a cut or wound, or even damp feet or clothes, causes leakage of electricity from the body, with consequent impairment of the vitality; and anything that will stop this leakage, repairs the lost vitality and heals the wound. A diver rubs himself over with oil for this purpose; likewise *trench-foot* or *frost-bite,* to which the soldiers in the trenches were subject, were readily prevented by massaging the feet daily with oil. Again, the application of pure paraffin wax to a wound or cut completely stops this electric leakage and heals it."

Compressed Air for the Sick

By GEORGE WALL

(*Continued from page* 251)

One will note the very ingenious scheme for dividing off the respective patients, which is made possible by designing each compartment complete, by itself; that is to say, each patient lies in a separate steel compartment in which the air pressure could be raised to any pressure desired, and maintained at that point for several hours or more, as required for the particular ailment under treatment.

On the outer wall of the compartment door in each case, there is provided an air pressure gage which indicates the pressure within the compartment in pounds and fractions of a pound, at all times. The orderlies who administrate the treatment, can pass along the central aisle between the two rows of compartments and keep a constant

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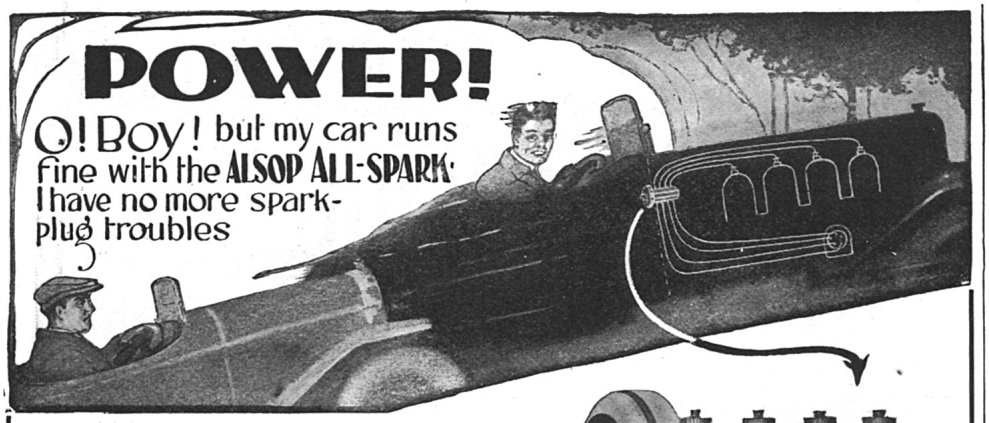

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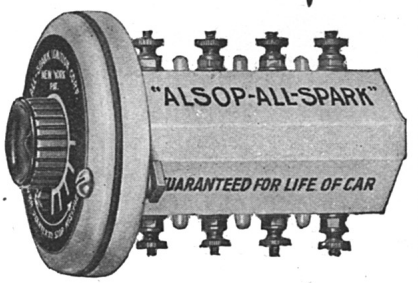

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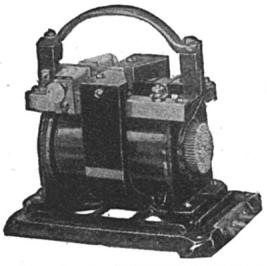

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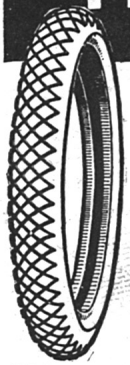

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watch or check upon the instruments attached to each berth.

Two tiers of steel berths are shown in the illustration herewith, which gives a very considerable capacity; a steel tube 12 feet in diameter by 100 feet in length is capable of caring for 125 patients.

As will be seen, the steel chamber is divided off so as to contain at the entrance end a consultation and diagnostic room containing lung testing meters, etc., for the purpose of ascertaining the strength of the patient's lungs, etc., so that too great an air pressure will not be administered. Of course, all the regular diagnostic points are carefully watched, such as the blood pressure, pulse, etc., before the patient has a prescription given for the treatment by compress air.

Arrangement of the machinery for maintaining the air pressure and also an adequate supply of fresh air for all times, is also quite ingenious, but withal very simple. Generally explained, there are two distinct systems of pipe and ventilation involved—one, for compressing the air and distributing it by means of suitable pipe lines and nozzle banks on each compartment, with suitable pressure regulating valves fitted at the exterior of the compartment, and secondly, a system of ventilation by means of automatic valves, whereby the foul air is released to the atmosphere as the pressure rises within the compartment.

In this manner, a practically continuous stream of fresh air under pressure is applied the patient. The air compressor is driven by an electric motor fitted with suitable regulating devices, so as to maintain the speed at a very constant value, which in turn insures a supply of comprest air at constant pressure.

Among other novelties in this comprest air sanitarium, we find pneumatic mattresses and pillows which can be inflated with comprest air, and then capt the same as automobile tires, these mattresses giving the utmost of comfort. Also, there is an air pressure testing cabinet made of glass, in which the patient can be placed and watched closely by the diagnostic physician, while the air pressure is steadily increased within the cabinet.

Moreover, the sleeping compartments are provided with telephones, so that in the event that the patient may become ill or faint, he can signal this fact to the attendants and, thanks to the telephone, they can carry on ordinary conversation without having to have doors open, which would cause a break in the treatment owing to the release of the air pressure.

The record of each patient is kept on a card secured in a suitable holder on each compartment door, and, besides this, there is a small glass window thru which the attendant can keep an eye on the patient.

AMERICAN LAMPS DISPLACE GERMAN.

Before the war in 1914 the whole of the lamp trade of Brazil was in the hands of the German "Osram" company, the lamps of which up to 50-candle power were sold by the retailers at about 29 cents to 30 cents. The Dutch "Phillips" lamp also had a certain sale, but not to be compared with that of the German product.

Since the beginning of the war American lamps have largely held this field, but, according to a report by John M. Glen of the British Electrical and Allied Manufacturers' Association, the American lamps have not proved so serviceable as the German lamps.

It is impossible to state the number of lamps imported annually into Brazil, but the author of the report was of the opinion that, considering the population, it is enormous, as may be judged from the number of hydroelectric plants thruout the country for lighting even the smallest towns and cities.

Practical Chemical Experiments

By PROF. FLOYD L. DARROW

(*Continued from page* 283)

peroxid and powdered charcoal. Place the mixture in a dry test tube clampt to a ringstand or other support and set behind a glass screen. Allow one drop of water to fall upon the mixture from the end of a long glass tube.

Potassium Chlorat and Red Phosphorus: To a pinch of finely powdered potassium chlorat add one-third that amount of red phosphorus and place in a previously folded paper, being careful to exert no pressure on the mixture. Place it on an anvil or brick and strike it with a hammer held in the gloved hand.

A Brilliant Display of Green Fire: For an evening display of fireworks the following is excellent: Scoop out a small hollow in a stick of willow charcoal. Then heat the charcoal to glowing in the flame of an alcohol lamp or a Bunsen burner. Immediately throw on a few crystals of barium chlorat and a very vigorous combustion accompanied by green light will take place.

Explosion of Chlorin and Hydrogen: In carrying out this experiment two precautions must be observed. The poisonous chlorin gas must not be breathed and the greatest care should be taken to keep the mixture of gases away from direct sunlight or very strong light of any sort, for under the influence of light they combine with explosive violence.

To generate the chlorin arrange apparatus as shown in Fig. 7. In the flask place two teaspoonfuls of manganese dioxid and then, having the apparatus in a good draft, pour thru the thistle tube concentrated hydrochloric acid until the manganese dioxid is well covered. Heat the mixture very *gently* and chlorin gas will quickly fill the cylinder. When full cover the cylinder with a glass plate and set it aside. Also remove your alcohol flame or Bunsen burner.

To generate hydrogen use granular zinc and dilute sulfuric acid (one part of acid to six parts of water, always pouring *acid into water*). Place the zinc in a generator as shown in Fig. 2 and pour the acid thru the thistle tube. Allow the action to continue for a few moments to free the generator of air, and then collect a cylinder of the gas over water in the usual way. Remove the cylinder by placing a glass plate beneath it while still in the water and invert it on your table.

Now invert the cylinder of chlorin over the hydrogen cylinder, bring them mouth to mouth, remove the plates and mix the gases by shaking. On removing the plates and applying a flame the mixture explodes with a loud report.

Combustion of Turpentine and Chlorin: Fill a wide mouth bottle with chlorin gas as described above. In a test tube gently warm a few cubic centimeters of turpentine and pour them over a large piece of filter or blotting paper. Then quickly thrust the paper into the bottle of chlorin. Spontaneous combustion will at once occur.

Explosion of Oxygen and Carbon Disulfid Vapor: Fill a very stout walled bottle with oxygen, generating it by heating a mixture of potassium chlorat and manganese dioxid and collecting the gas over water as shown in Fig. 7. Remove the bottle covering it with a glass plate and pour into it 2 c.c. of carbon disulfid. Shake the bottle and contents vigorously. Remove the glass plate and substitute for it a cardboard with a small hole in the center. Upon applying a match to the opening a sharp explosion is obtained. Unless the bottle is a strong one, wrap it in a towel.

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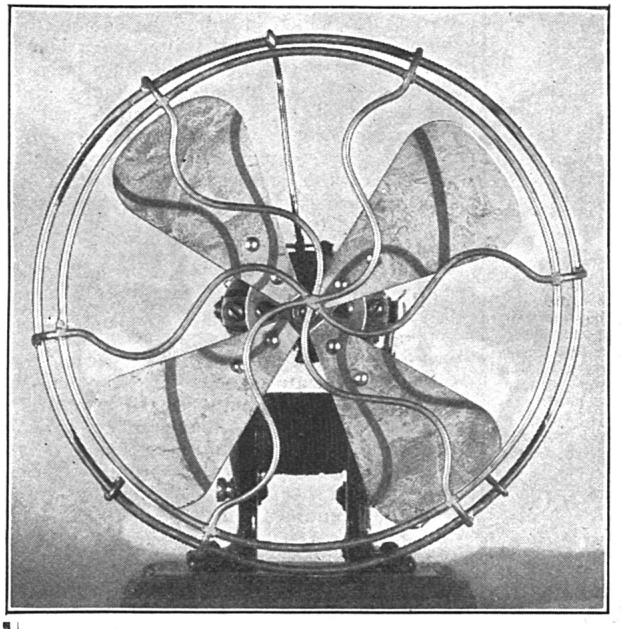

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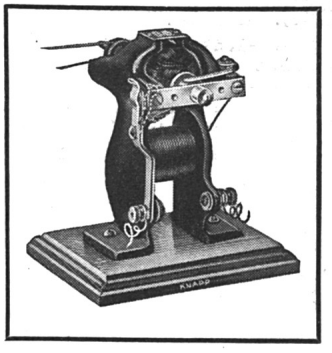

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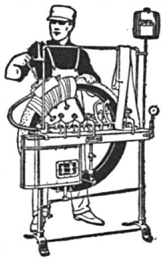

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The Tesla Gasoline Turbine

By JOSEPH H. KRAUS

(*Continued from page 277*)

operation as an internal combustion motor.

The upper part of the turbine casing has bolted to it, a separate casting, the central cavity of which forms the combustion chamber. To prevent injury thru excessive heating a cooling jacket may be used, or else water injected, and when these means are objectionable recourse may be had to air cooling, this all the more readily as very high temperatures are practicable. The top of the casting is closed by a plate with a spark-plug inserted and in its sides are screwed two of the new Tesla *valvular conduits* communicating with the central chamber. One of these is, normally, open to the atmosphere while the other connects to a source of fuel supply.

The bottom of the combustion chamber terminates in a suitable nozzle which consists of separate member of heat-resisting material. To regulate the influx of the explosion constituents and secure the proper mixture the air and gas conduits are equipt, respectively, with regulating valves. The exhaust openings of the rotor should be in communication with a ventilator, preferably carried on the same shaft and of any suitable construction. Its use, however, while advantageous, is not indispensable, the suction produced by the turbine rotor itself being, in some cases at least, sufficient to insure proper working.

But a few words will be needed to make clear the mode of operation. The air valve being open and sparking establisht across the gap, the gas is turned on slowly until the mixture in the explosion chamber reaches the critical state and is ignited. Both the conduits behaving with respect to efflux, as closed valves, the products of combustion rush out thru the nozzle acquiring still greater velocity by expansion and, imparting their momentum to the rotor, start it from rest. Upon the subsidence of the explosion the pressure in the chamber sinks below the atmospheric, owing to the pumping action of the rotor or ventilator and new air and gas are permitted to enter, cleaning the cavity and channels and making up a fresh mixture which is detonated as before, and so on; the successive impulses of the working fluid producing an almost continuous rotary effort. After a short lapse of time, the chamber becomes heated to such a degree that the ignition device may be shut off without disturbing the establisht régime.

The turbine thus shown presents the advantages of extreme simplicity, cheapness and reliability, there being no compressor, buckets or troublesome valve mechanism. It also permits, with the addition of certain well-known accessories, the use of any kind of fuel and thus meets the pressing necessity of a self-contained, powerful, light and compact internal combustion motor for general work. When the attainment of the highest efficiency is the chief object, as in machines of large size, the explosive constituents will be supplied under high pressure and provision made for maintaining a vacuum at the exhaust. Such arrangements are quite familiar and an enlargement on this subject is deemed unnecessary.

In speaking about the rapidity of explosions, Dr. Tesla says, "I have been able to speed up the rate of such explosions until the sound of exploding gases produced a musical note. The device is by far the simplest I have ever seen and I consider myself indeed fortunate in perfecting it at this time. I have also used this valvular conduit to great effect in rarifaction of air or the compression of gases when operated by my oscillator."

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Listening for Signals from Mars

By DR. FREDERICK H. MILLENER

(*Continued from page* 295)

was longer than any known station on earth we added more antenna and counterpoise until all our wire was in. Then carefully searching backward and forward, rearranging the various parts of our instruments, carefully tuning all the time, we searched for the signals which we hoped to hear.

NOT DISAPPOINTED

Had Mars been endeavoring to communicate with the earth, provided her signals were heavy enough to carry this far, our instruments would have picked up the waves which were going thru interstellar space, had these waves been of a similar nature, to the wireless waves generated on this earth, and as we understand them. As a result of this experiment it was evident to us that Mars was not sending wireless signals during the time that the planet was nearest the earth. We are not disappointed at the result. We did not undertake the experiment to prove that wireless signals were being sent from Mars, *but simply to discover if such signals were being sent.* We would have liked to accomplish the unusual and to have reported to the world the reception of signals from another planet. We realize that there is no good reason why some time in the future interplanetary communication should not be accomplished, provided there are intelligent beings on the other planets.

It is my conviction that at the present time we cannot receive signals from any planet. However, such communication might be possible with apparatus and methods which the future is bound to develop. This is not a failure, however, in not receiving these messages, but rather a negative result. In addition to the large antennae the apparatus was extremely sensitive, so sensitive in fact that when we disconnected the antenna and merely used a small portion of the counterpoise we had no difficulty in receiving the eastern stations such as Annapolis, New Brunswick, New Jersey, and Mexico City, Mexico. Just approaching your body to the coil would dampen out the signals.

The early part of the first evening that we listened in for these signals we were troubled with heavy static, so it was impossible to hear anything except stations in South America and United States. After two o'clock in the morning the static disappeared, the sky cleared and you could see Mars rolling her way thru space. It was after this time that we worked the hardest. When the wireless was stretched to its fullest extent, listening for interplanetary communication, we heard nothing that by any stretch of the imagination could be construed as a message from Mars. I believe that if any station on earth could have picked up any such message, ours could have done so. However, it is probably well for our reputations that we heard nothing, because if we had heard some signals we would have been promptly relegated to the Ananias class, no matter what evidence we would have had as proof of our statements. As it is, our mail has been full of rebukes, insisting that it was almost blasphemous for us to attempt such work.

Mars will be 35,000,000 miles from the earth about 1926. Mars is now on its way away from the earth and the greatest distance which it will reach will probably be 200,000,000 miles.

CORRECTION NOTICE.

An apparent oversight in the article "Wind And Rain to Order" in the June issue, failed to credit the photos to Universal Film Co.

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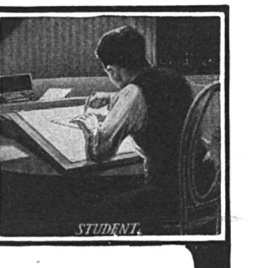

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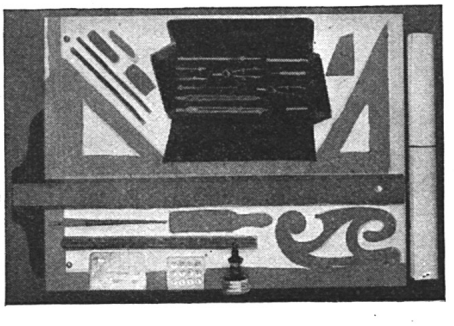

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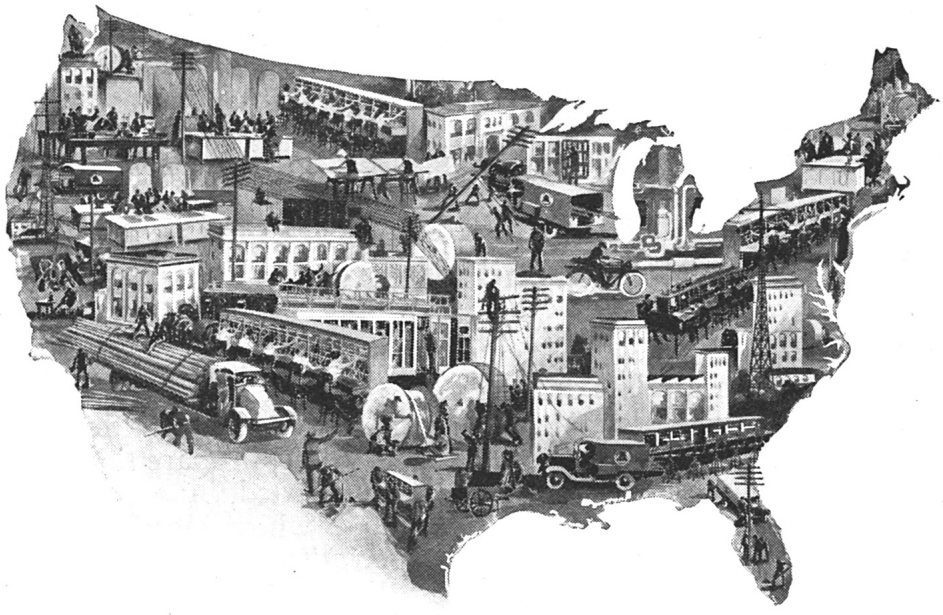

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My Message to Mars

By CLEMENT FEZANDIÉ

(*Continued from page* 267)

When Marty thoroly understood our numbers, I taught him a new word: "w-h-a-t." Thus, 2 + 3 = what? 5 + 7 = what? I would pause awhile after each question and then give the answers, and in this way taught him the very important word that signifies that a question is asked. This, and the word "equals" proved invaluable.

Next I taught him to repeat a message. I would begin a problem and then suddenly interrupt myself with a series of quick dots, and then I would start the message over again. Afterwards I interrupted his messages in a like manner until he learned that this sign meant "repeat." By this time, it was nearly bedtime.

"I'm going to ring off, now, Chuck," said I, "I'll just tell Mars to shut off the juice and call me up again at six o'clock tomorrow morning."

Chuck looked at me with a grin on his not over-handsome features.

"Yaw," he said with a wink, "I guess not."

"I'm not such a fool as I look, Budd. I know Mars' time is entirely different from ours."

"That's time enough, but I'm sure I can make Marty understand I want him to call me up at six o'clock."

"If you do, here's a ten dollar bill I had some trouble in borrowing, but I got it from a fellow who didn't know me. It's yours if you succeed."

"Well, you just *listen,* and you will see," I replied.

Had I known then the awful scrape I was destined to get into by my correspondence with the Martian, I should have hesitated. But with the recklessness of youth, I proceeded to put my scheme into execution.

It was a hard proposition I had undertaken, but I had thought of a method for making Mars understand our divisions of time. I began by sending out my regular call of three dashes repeated ten times. Mars already understood this to be a signal for attention. I waited exactly five seconds after making the call, and then wrote the figure "one" followed by two dots.

Five seconds later I sent the figure "two" followed by two dots, and so I continued, every five seconds giving the next numerals, always followed by two dots. Mars carefully repeated the message back to me, but evidently did not understand it. Then I tried a new trick. I gave the call again, waited ten seconds and gave the number "two" followed by two dashes. Then I waited 25 seconds and gave the number "five" with two dashes, then waited 35 seconds and sent the number "seven" with two dashes. I was about to continue, but Marty signalled me to stop and gave the call, and after a wait of fifteen seconds, he signalled the number "3," followed by two dots, and after five seconds more, the number "1" with two dots.

"He understands me, Chuck," I cried triumphantly. "He understands that two dots stand for an interval of five seconds. In other words, I have taught him to understand our time."

The rest was easy. After practising this at various intervals of time, I taught him to understand that I would leave the instrument and call him up again at the expiration of 40 seconds, 60 seconds, etc. After that, it was a simple matter to tell him to call me up at six o'clock the fol-

lowing morning. It was now midnight, so I told him "call: $72 \times 60 \times 5$ seconds."

I only waited to hear Mars repeat the message, then I gave a farewell rat-tat-tat on the instrument and hied me to a much needed rest. The next morning, I was at my instrument again, and sharp at six o'clock I heard Mars calling me. He was exact to the very second!

Chuck, who was with me, reluctantly pulled his ten dollar bill from his pocket and handed it over to me in payment of his bet. But as he borrowed twenty-five dollars from me that same afternoon, I didn't make much by the transaction.

This second day, I began by teaching my Martian friend the words "yes" and "no." To do this I again employed simple examples in addition and multiplication, making use of the question mark I had already taught. I wired: $2 + 3 = 5$? And after a pause sent a word-sign for "yes." Then $2 + 3 = 8$? And then sent the word sign for "no." After a dozen such messages Mars undertsood "yes" and "no," tho it was only later I taught him the distinction between these and "correct" and "incorrect."

Then I started teaching him squares and cubes and circles, lines, surfaces and areas. Marty was now familiar with numbers, so I merely wired: 3 square = 9, 4 square = 16, 5 square = 25 etc., and soon had Marty calling back 9 square $= 9 \times 9 = 81$, showing that he had learned the new word "square." The word cube and sphere were even easier. For fractions I used the form $1 \div 2$ for one-half, $3 \div 4$ for three-quarters, etc. So that π or 3.1416 by our system became $3 + 1416 \div 10{,}000$.

Circle 3 boundary $= 2 \times 3 \times (3 + 1416 \div 10{,}000)$.

Circle 4 boundary $= 2 \times 4 \times (3 + 1416 \div 10{,}000)$.

Then, Circle 3 area = 3 square $\times$ $(3 + 1416 \div 10{,}000)$.

Circle 4 area = 4 square $\times$ $(3 + 1416 \div 10{,}000)$.

Circle 3 volume = 3 cube $\times$ $4 \div 3 \times (3 + 1416 \div 10{,}000)$.

Circle 4 volume = 4 cube $\times$ $4 \div 3 \times (3 + 1416 \div 10{,}000)$.

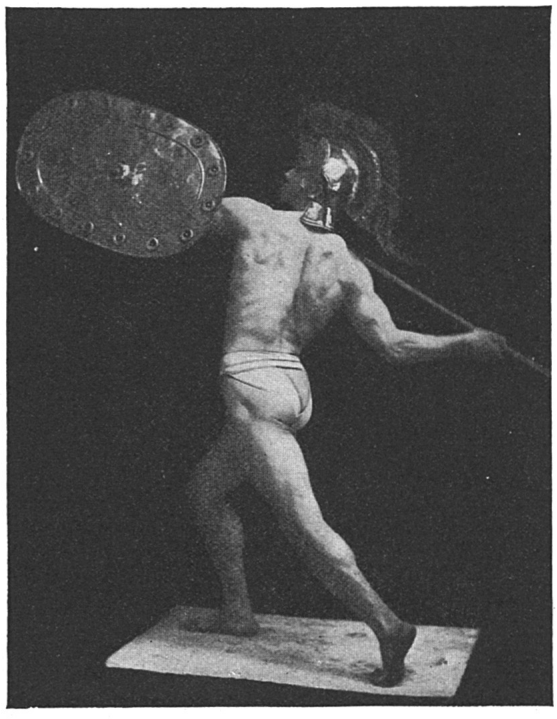
It took an hour for him to understand that I was sending him the circumference and area of circles of radius 3 to 4 and the volume of a sphere of the same radius. I may state here that I did not use the number 3.1416 for π, but its Martian equivalent in the duodecimal system, namely 1.6220, which must have been as familiar to him as 3.1416 is to us, and thus suggested a circle at first sight, as the latter would to us.

The parenthesis or brace used above I had taught by simple examples in arithmetic and algebra. Thus after 3 square = 9 and 4 square = 16, I wired brace 3 + 4 brace square = 7 square = 49, using the word brace before and after the numbers to indicate a parenthesis. Repetition of this process with other numbers soon taught my Martian friend that two braces indicated the coupling together of the numbers between. Then (a + b) square = a square + 2 $\times$ a $\times$ b + b square, and (a + b) $\times$ (a—b) = a square —b square, taught him the use of "a" and "b" to represent any numbers. For "X" I used the word "what," which I have already explained that we used as a question mark.

Well, I shall not weary you with the details of our progress. A single example will suffice to show you the method I followed, and what roundabout ways were often required to teach my Martian friend the simplest things.

I will take the case of our weights and measures, which I had some trouble in making Marty understand. As a preliminary, I wired a few phrases like the following: (3 $\times$ 1 foot) $\times$ (3 $\times$ 1 foot) =

An Ancient Greek Athlete



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Finally Milo noticed that the calf had grown to a fair size, but he could now lift it easier than on the first day. He also noticed that he was becoming bigger and stronger, and could out-do his playmates at any of their games. The calf grew to be a huge bull, and Milo was still able to raise it from the ground. The weakling had become a famous athlete.

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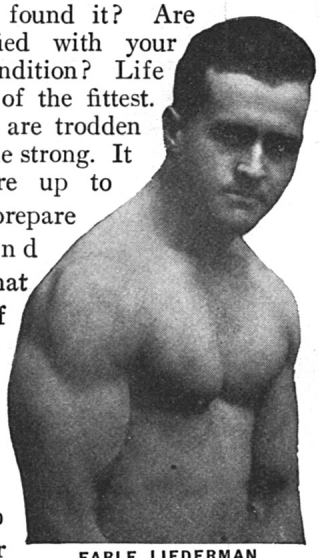

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9 × 1 foot × 1 foot = 9 × 1 foot square. He soon understood that the word "foot" stood for some linear measure and "foot square" for the same unit of surface. But of course he could not tell whether a foot meant one inch or one mile. To teach this, some object of comparison was necessary, and for this I was obliged to have recourse to astronomy. I first planned to teach him about the planets, but had to give this up as too complex. A much simpler method was to confine myself to the Sun, the Earth and Mars. That my correspondent lived on Mars I was now certain as I had succeeded in locating the exact direction from which his wireless impulses came.

I began by teaching Marty the word "noon." For this purpose I had an astronomer friend make me out a table of the time by our clocks when it would be noon at Mars each day of the year and also the time of the rising and setting of the Sun on Mars.*

Then for several days running whenever I stopt wirelessing I calculated how many seconds would elapse before his noon-time and notified him I would call up then. He could not fail to perceive the fact that my messages always arrived sharp at noon. That he did so and that the Martians understood something of astronomy was evident when in return he called me up for the next week sharp at noon-time by our time, —that is to say when the sun was on the meridian here. The word "noon" was then easy to add to our vocabulary. "Call noon = call 23 hours" did the work, for by this time I no longer counted by seconds but had taught him that 60 seconds = 1 minute, etc.

When he thoroly understood Noon as the time when the sun was on the Meridian at Mars, I taught him Earth Noon = Noon + 83 minutes since our noon was then 83 minutes later than his. He thus learned the word "Earth." Then by comparing Earth Noon and Mars Noon, I taught him the word Mars. To teach him the word "sun" was then comparatively easy. Noon + 6 hours = Sun stop. Sun stop + 12 hours = Sun begin. Sun begin + 6 hours = Sun noon. For "stop" and "begin" I used the signs we used for beginning and stopping our messages. Mars readily understood and wirelest back the time of sunrise and sunset on our earth.

All this preliminary work being accomplisht, I could now teach Mars what a mile was. I merely radioed him the volume of the Sun, the Earth and Mars in cubic miles and their surface in square miles; he then knew the exact length of one of our miles, so when I informed him that 5280 feet = 1 mile, and 12 inches make one foot, he understood our linear dimensions.

For weight I wired how many times one Earth made one Sun, and how many times one Mars made one sun. When he understood this I taught him the word "weight" by repeating the above, inserting the word "weight." Then I wired how many pounds the earth weighed and how many Mars weighed and so taught him what a pound was, which opened the way to teaching him all our weights.

Here I was indiscreet enough to stop to ask him how old he was and how much he weighed and learned to my surprise that he was 153 (terrestrial) years old and weighed one thousand pounds (earth weight)!

My next achievement was to teach him our elements. I sent him a complete table of the elements arranged in order of their atomic weights with their symbols and weights (atomic weight) and was delighted when he sent back a much more complete table with many elements we have not yet

** Just a trifling slip of the author: It is "noon" every second, all day long, somewhere on Mars, just as it is on Earth*—EDITOR.

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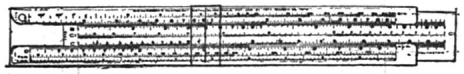

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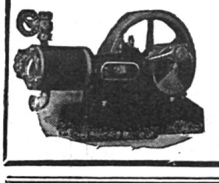

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discovered. For these he had given Martian names. Then I sent him chemical compounds and formulas. For instance $H_2 SO_4$ would be wired as 2H + S + 4O.

In return Mars sent me many chemical formulas for compounds we have as yet no knowledge of here. I have taken careful note of them and expect to make my fortune by working them out as soon as I have time. My last trouble came in teaching Marty our alphabet. He now had a large vocabulary of English words, so I changed the symbols for these by sending for arbitrary words such as "Sun," "Mars," etc., its equivalent in letters in the Continental code. The use of the equal sign rendered this change easy. Then I separated each word into its component letters, sent several words in succession that had the same letter in them, and finally sent the whole alphabet in order a number of times.

It was some job, let me tell you, worse than to teach a deaf-mute how to write, but I finally succeeded. After that, everything was comparatively plain sailing, for I spelled out simple sentences containing the words he knew and adding one new word occasionally whose sense could be seen from the content. He learned, just as a child learns.

Finally, after several months, I could make him understand almost anything, even music which I wired by sending the number of vibrations per second for each note.

And then came the surprise of my life, for on making some inquiries in regard to the people on Mars, what was my astonishment when the operator on the other end informed me that she was a *woman!*

Here I had been for months intimately corresponding with a lady, and without any other chaperone than poor simple-minded Chuck! Lack of space forbids my telling you all I learned about the Martians, their history, customs, habitations, etc. Besides, it is all so wonderful, I fear my readers would disbelieve me and this would tend to throw doubt on the rest of my narrative.

On learning that my fair correspondent on Mars was a lady, I became desirous of seeing her likeness, so resolved to teach her our newspaper method of telegraphing pictures by the use of two co-ordinates for the main points in the outlines of the drawing to be transmitted. I began with simple geometrical forms, beginning with the semi-circle (half-circle) with which she was already familiar. I had by this time taught her the words, "line," "join" and "point," "diameter" and "perpendicular."

I first told her to draw a line five inches long. I then telephoned her to draw perpendiculars one inch, two inches, three inches, etc., from the beginning of the line and mark off points at the proper distances on these diameters and then join these points with a line. This line would evidently be a semi-circle. I then sent her the outline of squares, triangles, ellipses, spirals, etc., in the same way, thus not only opening up the entire study of analytics and calculus, but also enabling me to send and receive drawings of any objects desired.

I hoped by this method to secure not only a photograph of "Miss Mars," but also pictures of many other objects on Mars which I should have been most happy to send you for the benefit of your readers, had it not been for a startling event that came like a thunderbolt out of a clear sky and put a stop to all further communication with Mars.

Yesterday I wired to my Marchioness—excuse me, my Martianess as usual—and after some preliminary talk I was dumbfounded when she sent me the following message:

"Bud, will you marry me?"

I was so flabbergasted I couldn't stop to calculate how it happened that Leap Year

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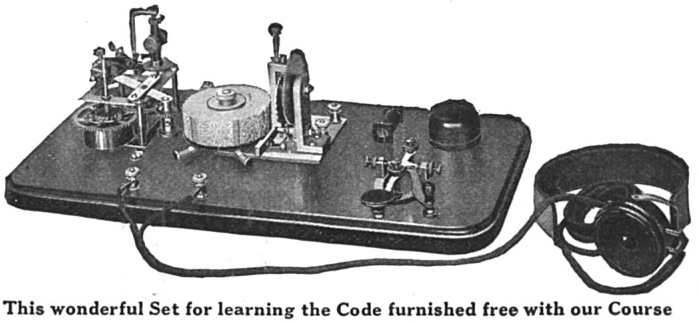

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occurred on Mars at the same time as on the Earth, and I was so flurried that I answered "Yes" before I knew what I was doing. Then I rang off.....

Now, I don't know what to do. I am in an awful fix. Here I am pledged to a Martian girl 153 years old and weighing one thousand pounds. I haven't the faintest idea what she looks like. I may be engaged to a spider or a snake or something a hundred times worse, and I fear that any day she may drop down from heaven (?) and claim the fulfillment of my promise.

What can I do? If any of your readers can help me out of this muddle I shall be truly grateful.

(Down to the last few paragraphs we took Mr. Fezandié quite serious—the stuff read pretty smooth and logical. But right here we scratch our editorial heads and begin to wonder, wonder..... As a matter of fact we think he's been spoofing us (as our English friends say), or in plain American we have an idea he's trying to kid us. Of course, we won't stand for that, so we are sending his story right back to him!—EDITOR.)

Care of the Lead Plate Storage Battery

By JESSE J. HIPPLE

(*Continued from page* 286)

should be taken from the point that the hydrometer scales meet the lowest point of the convex surface of the confined liquid. (Fig. 2.) Most hydrometers are calibrated for a temperature of 70° Fahrenheit, and for extremely accurate readings the temperature should be taken into consideration and compensated for. This, however, is not necessary for ordinary work. The voltmeter is also a source of unfailing information as to the true condition of a battery and should be used in conjunction with the hydrometer. A battery is ready for recharging when the individual cells register a voltage of 1.75. Storage batteries should be watched constantly and some sort of a chart should be devised so that any radical change in performance can be noted and the trouble found before it ruins the entire set. **Vigilance is the price of service.**

DISEASES OF BATTERIES.

Battery diseases may be divided into three general classifications: (1) Sulfation, (2) Contamination, and (3) Loss of capacity.

Sulfation: Sulfation is caused by discharging a battery too low. A cell should never go below 1.75 volts. To correct sulfation, a battery that has been heavily sulfated should first be given a quick, heavy charge to loosen the sulfate and then the jar cleaned out and the battery discharged. After this the battery should be given a long, light charge until the hydrometer is up to the point required. Never allow a battery to stand discharged.

Contamination: There are many sources of contamination but the principal ones are (1) Iron, (2) Sea water, (3) Copper and (4) Mercury. All the above sources may be guarded against by cleanliness.

Loss of Capacity: Loss of capacity may be caused by overcharging, gasing, standing idle, contamination, short-circuits and many other things. The principal cause of short-circuits is wet battery tops, i. e., wet with acid, possibly from spray produced while charging.

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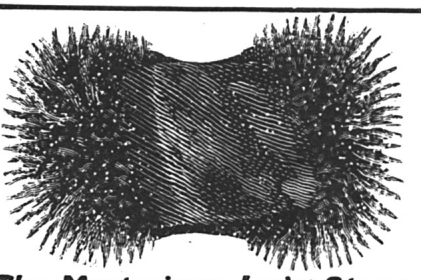

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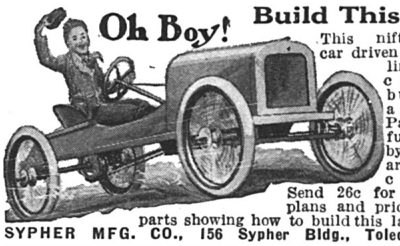

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BATTERY TROUBLES AND REMEDIES.

When the level of the electrolyte in one cell chronically lowers faster than the others, look for a cracked or leaking jar. When found, cut the cell out of the battery and substitute new one, using the old plates and electrolyte.

When one cell tends to discharge faster than the others (shown by voltmeter or hydrometer readings), it should be cut out and examined for both external and internal short-circuits.

External short-circuits are caused by acid wet tops and internal short-circuits may be caused by an *accumulation of sulfate in the bottom of the jar* (see Fig. 4-A), punctured separators, fallen plates or contamination. It is obvious what should be done should any of the above conditions exist.

If a battery will not deliver current and the individual cells show up well in voltage and gravity, the lugs and connectors should be examined for a break. If one is found it may be easily mended by burning on a new part with a small alcohol torch and a blow pipe.

If a battery takes a full charge but does not hold it, look over it for short circuits or sulfation. A remedy for both these conditions has been given in the earlier part of this article.

The above will also apply to batteries that will not take a charge. That is, it is caused by either short-circuiting or a broken connection.

CHARGING

When a new battery is assembled it is given a full charge and then discharged. It is then charged again up to its full capacity and put into service. To charge after that, the following rules should be followed. First be sure that the *positive terminal of the charging circuit connects with the positive pole of the battery* and that the negative pole of the battery connects with the negative terminal of the charging circuit. The polarity of a circuit may be found by holding the two wires in salt water. The wire on which the most bubbles collect is the negative terminal. Remove the filler plugs and the battery cover. Most batteries contain the charging voltage and rate on the name plate. This should be followed closely in most cases. For general practise, however, the following is a safe rule: For a six-volt, 60 A. H. battery, the charge should start at about 7 or 8 volts and 15 amperes. This charge should continue until the batteries begin to "boil," or in other words until the gas generated comes off in fairly large quantities. When this stage is reached the amperage should be cut down to about 5 amps and the charging allowed to continue until the cells begin to gas again. Record should be kept every hour of the gravity and temperature during the charge so that when the battery registers full density and voltage, the charge may be continued for another hour and stopped. The cells should be guarded from overheating and when the temperature rises to 125° Fahr., the charging rate should be reduced or the charge stopt until the temperature reduces. A convenient way to charge is to give a battery an hour's charge at about twenty amps and then allow the charge to continue at five amps until finished. This is more convenient, but it takes a longer time and is not as efficient as that method where all stages are carefully watched. **Keep an open flame away from a charging battery because the gases generated include Hydrogen and Oxygen in their most explosive proportions.**

When transferring a charged set of plates from one jar to another they should be placed in a jar of distilled water until their new jar is ready for their reception. In no case allow them to be exposed to the air for any length of time.

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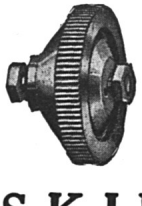

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An Efficient Primary Battery

By W. S. STANDIFORD

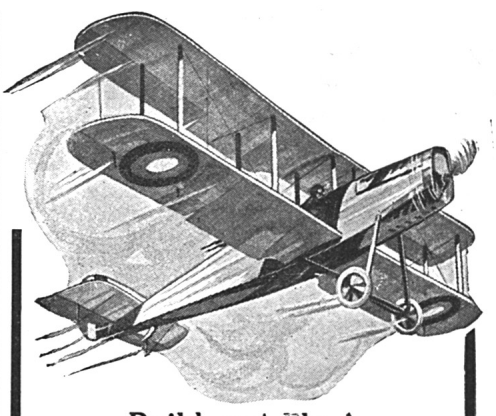
(*Continued from page 289*)

the binding post on the cover; bore a hole alongside of it to fit the copper wire, scrape the insulation off end of wire and twist the latter around the tang of the binding post, screwing the base of the latter down on it tightly. Allow enough insulation to remain on the wire after it passes through the board so as to extend to 2 inches below the top of the porous cup. Remove the rest of insulation from wire and brighten the latter with emery cloth. Coil the wire around the porous cup, but keep it closely touching the inside surface of glass jar, and as far away as possible from the side of the porous cup. If desired, the wire (with its insulation left on except the part under the binding post) can be extended straight down to the bottom of the jar, the end to have the insulation scraped off, brightened with emery cloth and twisted in a single loop around the porous cup, it being away from the latter's side, as previously described. Either method of wire arrangement is good. On the bottom of the coke spread a layer of copper sulfate crystals; don't put them against the sides of porous cup, but have some pieces of coke next to it. On top of the sulfate and wire loop put a layer of coke. Continue the process, alternating copper sulfate crystals and coke until the mass is within one inch of the top of the porous cup. Fill the space around the zinc in porous cup with coke, the latter pieces to be the same size as those in the outer jar and also at the same height.

Next pour water into both the porous pot and outer jar until it is on a level with the coke, or one inch below the top of the porous pot. Connect the two binding posts together by a wire until a current flows, then disconnect them and the battery is ready for use. It will be found that, unlike the regular pattern of Daniell cell, the zinc in this battery will keep free from copper when it is left on open-circuit, and when used on a closed circuit the zinc keeps very clean. The pieces of coke in the outer jar soon become coated with copper, and owing to the large surface exposed, the resistance is lowered, which allows a larger current to flow. The voltage of this cell is over 1 volt. To charge a storage battery it is best to use 4 cells connected in series, that is, connect the outer jar binding post of one battery to the zinc of another cell, repeating this until all of the cells are connected together, then connect the terminals of the end cells to the storage battery. Connected thus, in series four of the new type of Daniell cells gives about 4¼ volts. In charging a storage battery it is best to have a sufficient number of primary cells so as to give double the voltage of the storage battery; this makes the charging chemicals in the former last longer and the primary batteries keep in better condition than when they are worked to their full capacity.

Editor's Note

The second illustration shows a cell which is recommended by the editor. It will be noted that instead of the copper wire a copper netting is used, and instead of a zinc pencil, a zinc cylinder. This arrangement gives about ten times the amperage of the former, due to the large opposing surfaces. This battery is exactly the same as the one described by Mr. Standiford. The advantage of this battery is that due to the large surfaces used, the ampere hours capacity of the battery is very much larger.



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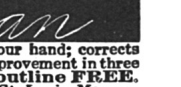

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Nature's Jewels

By WILLIAM M. BUTTERFIELD

(*Continued from page* 258)

Among such masses on the earth the size of the crystals range from a minute speck, hardly visible under the microscope, to huge prisms nine feet across and four hundred feet high. The shapes are almost incalculable in the number of their variations. But there are only about seventy-two elements, each of which form its separate family design, as of course there is only about this number of primary shapes. Some kinds are formed under enormous pressure, as the diamond beneath the earth's surface; some harden slowly like basalt; others form quickly like ice. All are produced by a common mechanical process in which the loss of heat in a liquid is the principal cause.

Heat in various degrees required for making the transformation causes every known mineral substance to assume at least two forms, a liquid and a solid, not to mention a third form (gas or vapor) which all mineral substances are at some period compelled to take, but which does not usually enter into the process of crystallization. These three forms of matter, as all the combined substances of the earth are called, are seen in panoramic splendor in the sky, or in the oceans and fresh water bodies that form nearly four-fifths of the earth's surface.

It will be interesting to examine these in order that we may better understand how force, such as heat, gravitation, cohesion and such agents in mass are called, act upon matter. The blue of the sky, the ever-changing clouds, the mists, fogs and dews illustrate for us different densities of water vapor. We have all observed vapor in the act of forming; we have seen it change into the various stages under the heat of the sun, and we understand from these common observations that heat can and will convert water into vapor. Water, therefore, in its rarest form (as we see it in the blue vapor gas of the atmosphere) presents to us an understandable example of matter in a gaseous form.

Commencing with this gas, nature reduces in gradual stages the high degree of heat that is responsible for it, and soon we see a series of reverse changes. First, light, fleecy clouds; then thick, heavy, black masses; and finally a fall of rain. Having reached this stage we see water as a liquid, the form we best know. But with still lessening degrees of heat we shall see water form into ice which is the third or solid form.

One is always surprised at these changes, and it never seems possible that water can be converted first in one direction and then in an entirely different one without being destroyed. Let us review this interesting part of the story and observe the simple mechanical movements that cause the changes and preserve water from destruction.

Water is a compound formed of two elements—hydrogen and oxygen and each element is composed of countless invisible and extremely minute particles called *atoms*. These atoms are indestructible and are always separated from each other by a kind of matter called *ether*. Each atom, according to its kind, is supplied with two or more attracting poles that somehow attract atoms to each other. Therefore, the tendency of all atoms of the same element is to fly towards the others, thus forming as compact a mass as the forces which control them will allow. In compounds, such as water, the atoms of one element have what is called an affinity for those of another, and form compound particles called

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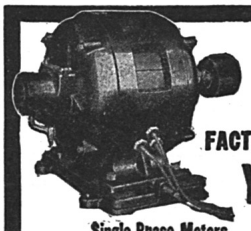

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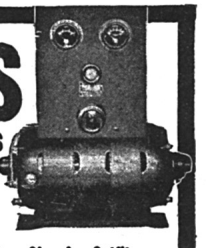

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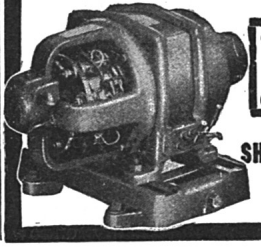

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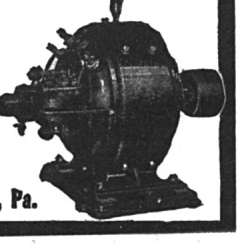

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molecules. The molecules of water are composed of two atoms of hydrogen and one of oxygen.

This, in brief, is a description of the structure of water. Now, if in our imagination we place the molecules apart or cause them to come together just as we actually can a cupful of small pebbles, we may form a mental picture of the mechanical movements that are responsible for the different degrees of density of substances, causing the three forms of water. These bodies are the furthest apart as vapor gas, semi-distant as water and nearest when it has been converted into ice. One can also see clearly that these movements can go on forever without destroying water.

Because water has proven such a convenient substance for illustration, let us go a little farther with it. We have seen that compound liquids have molecules composed of atoms of its different elements. These molecules can be destroyed by the atoms separating of their own will or energy; that is, they appear to have an action more resembling vital force than a mere mechanical or automatic movement, but only noticeable at the time liquids freeze or turn into solids the time when atoms are close together.

It is at this time that nature constructs her crystals, and it is in the construction of these forms that the atoms show their peculiar powers. So far as we are able to learn from observation, they are all formed in the same way and all appear, when observation is possible, to be endowed with constructive powers. By this we mean that the billions of individuals of any one of the seventy-two or more elements will, under like conditions, develop shapes that are taken only by members of their family. This constructive power in each form is entirely the product of the mechanically controlled atoms of the element.

In a compound, when freezing, the atoms in the molecules are made to lose their affinity for each other and fall apart, thus destroying the molecules. Then the atoms of each element fly to its kind to arrange themselves in the order necessary to form their family crystals, and this change is remarkable for these bodies do not exist in a separate state in liquid or in gas. We can see the effects of these independent movements if we examine crystal formation under a lens. In the orderly development of the forms, growths show the mathematical exactness with which each atom attaches itself in, what would seem, its self-appointed position. It is in this manner that the elements of a compound develop their independently formed crystals. In the next process there are two, the dry and the wet. These forms feed, as it is called, from the liquid; that is, the atoms continue to attach themselves, thus forming large or small crystals.

Living stone is not an idle thought, for many stones or other solids grow in the manner we have described. The crystals show various other indications of that mysterious something which we are pleased to call vital force or life. They are influenced by geographical location, for instance, and to such an extent that experts can tell, by certain locally influenced development in members of a single element, the locality in which they were created. Vibration, concussion, galvanic or electrical currents, not to mention heat in various degrees, have their share of influence also. Then they show many characteristics that are usually thought to be only the rightful possession of the highly developed animal and plant. Some are peaceful, unassuming, defenseless; others are warlike, thus eating into, bending or entirely destroying the growth of others; then there is the obnoxious parasite, living at the expense of its host.

But we have seen that the crystal, a mere product of atoms, is not really endowed

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with independent action, and that which it seems to do voluntarily is really the result of atoms performing their functions. We have followed the course of atomic movement from the formation by these bodies of vapor-gas, of water and from water to the formation of crystals. Let us now go a step farther.

We will take ice as an illustration of the method of solids forming from the individual crystal. Water is a mineral species and its crystals are hexagonal or six-sided; these form into compound stellate or star-shaped forms. Ice is transparent owing to the close contact of the crystals which compose it; this makes the individual crystals blend so as to render the mass optically as well as mechanically continuous. Looking at a piece of ice, therefore, we do not see the crystals, altho we CAN see the stellate compounds at the moment the ice starts to freeze quite plainly. A block of ice may be described as growing from a single stone, thus the atom attracting other atoms and developing a hexagonal crystal; this crystal forming with others a stellate form and the stellate form building with others the block of ice.

If the reader will glance at our chart of drawings he will obtain a fairly comprehensive idea of crystal shapes. In the upper left-hand corner, Fig. 8, are six snow crystals showing compound forms somewhat like the ice crystal spoken of above.

All of the various elementary forms are divided by certain mechanical influences into three common kinds of growth, the needle or hair varieties (Figs. 9, 10, 11, 15) or a filamentous arrangement of the stones; the prismatic or knotted varieties, of which many forms resemble the polished jewels of man; and the flat or leaf kinds, illustrated by the scale-like crystals of mica (Figs. 8, 12, 13, 18).

The sharp edges of these geometrical forms, their high finish and brilliantly smooth surfaces, together with their machine-made appearance, make crystals always seem as tho a product of some human creative genius rather than the work of nature. When one observes growing crystals as one may in salt, borax or sugar solutions, the exhibition of Nature's jewel building is made doubly interesting by knowing something of the methods that are used. The interest in a diamond is increased when one knows that it is formed in the manner we have described and not cheapened by knowing that rock crystal, glass or ice is formed in much the same way. Altho there are many solids, combinations of particles or invisible grains recreated by Nature or by man, the original materials of which they are composed was made from liquids in the form of crystals. And all can, like ice, be reconverted into liquid or gas to undergo a common readjustment which the Creator has provided.

EDISON MEDAL PRESENTATION.

The annual meeting of the American Institute of Electrical Engineers was held in New York in the Auditorium of the Engineering Societies Building on May 21, 1920, at 8:30 P. M.

On this occasion the Edison Medal was presented to Mr. W. L. R. Emmet "for Inventions and Developments of Electrical Apparatus and Prime Movers" in accordance with the award of the Edison Medal Committee of the Institute.

The program for the Edison Medal presentation included: 1, The Edison Medal, by Carl Hering, Chairman Edison Medal Committee; 2, Achievements of W. L. R. Emmet, by H. W. Buck; 3, Presentation of the Medal, by Calvert Townley, President A. I. E. E.; 4, Response, by W. L. R. Emmet.

Non-members of the Institute including ladies were cordially invited to attend this meeting.

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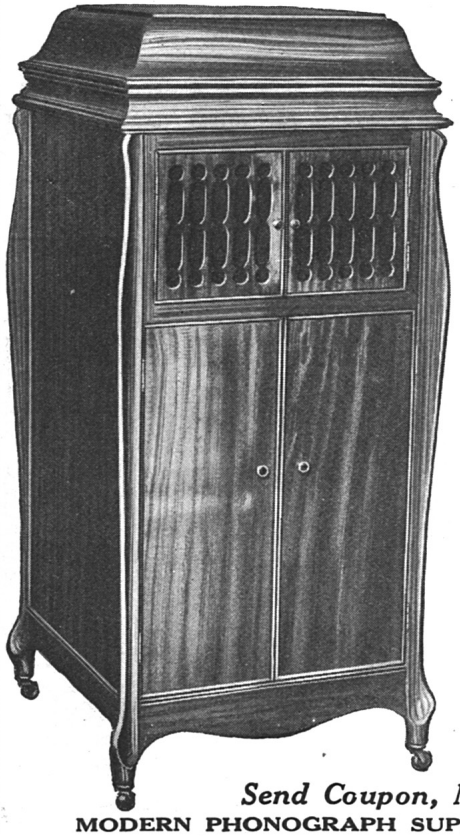

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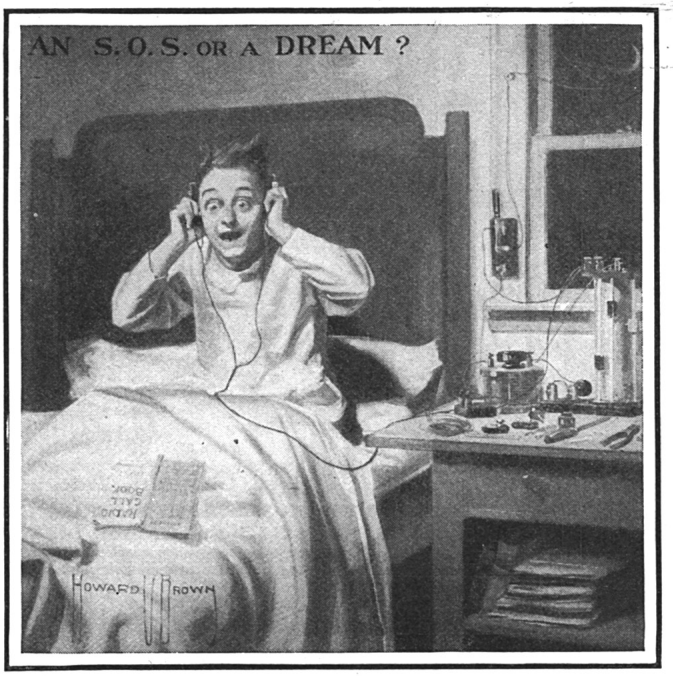

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TELEPHOT.

(392) R. M. Thomson, of Foxton, Colo., has the following to say:

I beg to submit the following idea for seeing faces at a distance by electricity and would be pleased to have your opinion regarding it.

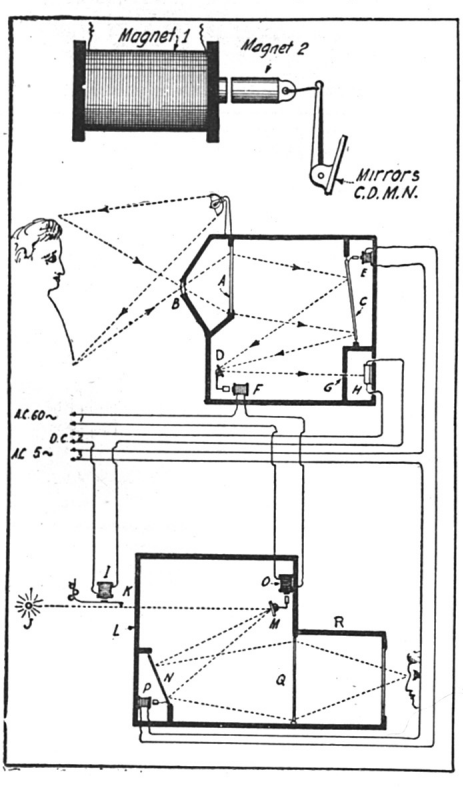
At the transmitting end the image is thrown on the ground glass plate (A) by the lens (B). From here it is reflected by the mirror (C) (whose reflecting surface is about one-sixteenth of an inch wide and five inches long) to D.

These mirrors (C, D, M, N) are vibrated as shown in the upper left-hand corner of the sketch. As like poles repel and unlike poles attract, the magnet (1), when energized by an alternating current, will vibrate magnet (2) with the same speed as the alternating current. E and P should have a current of about five cycles and F and O about sixty. C and N vibrate from left to right and D and N vibrate up and down. The idea of these vibrating mirrors is to send part of the picture over the wire at a time and to reproduce it at the receiving end so quickly that it appears as a complete picture to the eye.

The picture, now condensed into one ray of light, falls on the selenium cell (H) thru a pinhole (G) in the form of impulses which are sent over the wire to the magnet (1) at the receiving end. This magnet attracts K according to the electrical impulses and interrupts the light ray from J. The light ray then enters the dark box (L) thru a pinhole. Here it strikes the small vibrating mirror (M) which reflects it to N and to the ground glass plate (Q) in the same shape as on A.

The alternators for circuits 1 and 3 of course would not run exactly together so that the mirrors (C and D, M and N) would not cover the same surface of the picture in the first half of a cycle of circuit 3 than in the second half. The ground glass plate (Q) is shaded by a second box (R) to keep the interior of the main box dark.

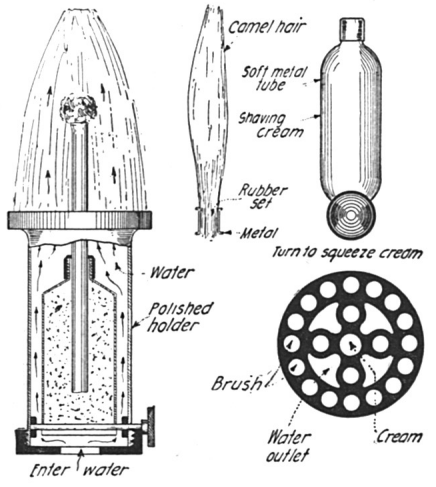
A. A very interesting idea, which might be developed into a working model. It looks feasible on paper and we thing a patent might be obtained on same. We would advise our correspondent, however, to build a model by all means first, as upon this everything hinges. We might say that while on the whole the idea looks new and original, the scheme of the vibrating mirror is not original, having been used some years ago by the Pole, Szecepanik, altho we do not know whether actual models had been built by him at the time.



SHAVING BRUSH.

(393) Geo. Hortig, Montreal, Canada, writes us: "Could you give me advice whether a patent can be secured on a shaving brush as per illustration. How is a patent secured and is there any money in marketing such an invention.

A. This seems to be a good idea, and we think it will fill an actual want. The combination of the shaving cream tube and the brush in connection with the automatic dispenser should make an instant hit with the average man who has to shave every day and who has not much time to fuss around. If the device can be manufactured cheaply, it should have a good demand. We would advise our correspondent to get in touch with a patent attorney.



AUTOMATIC DOOR OPENER.

(394) Robert Klaus, St. Louis, Mo., writes: I enclose several sketches for an automatic garage door opener for different types of doors, and the same plan could be used on many other types. I would like to have you tell me whether or not a patent could be secured on this."

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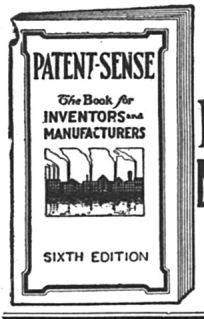

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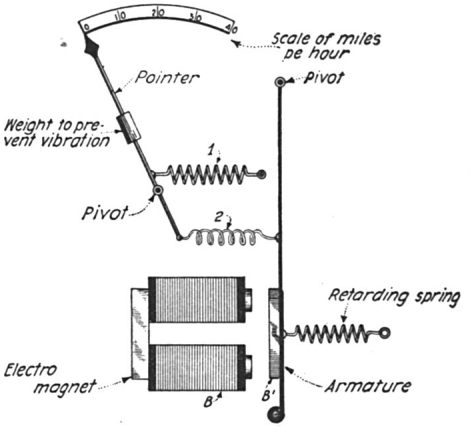
A. The scheme contained in this idea is a good one, and altho we think it is rather somewhat complicated, we believe that a patent can be obtained. How valuable such a patent would be we have no means of knowing. There is no doubt a demand for automatic door openers, particularly doors used on garages, but how big this demand is we have no means of knowing.

SPEEDOMETER.

(395) F. Kilgore, Largo, Fla., writes as follows: The invention which I will now describe is called an electric speedometer. Its chief use would be on automobiles. The electric current would be supplied by the storage battery of the car. For simplicity I will describe the part showing distance first.

At the front wheel of the auto is a circuit maker which completes the electric circuit three times for each revolution of the wheel. For different size wheels a different ratio would be employed so that the auto would travel four feet ahead for each completion of the circuit. In the circuit is an electromagnet located at the dashboard of the car. The armature of this would move up to the electromagnet every time the car moved four feet ahead. Attached to the armature is a ratchet which gradually revolves a cog wheel and shows the distance the auto has traveled.

As to the parts showing speed we will start again at the circuit breaker or maker. This keeps the current flowing for only 1/30 second no matter how fast or slow the auto is traveling. Such circuit breakers are reliable enough, being used in one of the best systems of auto ignition. Thus the amount of time the current is flowing is proportional to the speed of the car. And the amount of time the armature is in the B position (see illustration) is proportional to the same.



Springs 1 and 2 tend to contract, but spring 2 has the greater power when the armature is at B, thereby keeping pointer at zero. But when armature is at B, then No. 1 has greater power and pulls pointer around to 40. So the distance the pointer is moved to the right is proportional to the speed of the car.

Is this device patentable?

Is there any similar one already on the market?

Could it be manufactured cheaply enough to compete with other speedometers already on the market? It would possess two distinct advantages. First, there is no connecting chain which is the most troublesome part of the common speedometer; second, there are no permanent magnets to weaken and permit the speed readings to be low. The current consumed by properly made instrument would be low, about 2 amperes for 1/30 second from a 6 volt storage battery. A condenser could be added if necessary to prevent sparking.

A. The idea, while ingenious, is not new by any means. There have been on the market speedometers of this sort, and there are in use now some types that seem to be a good deal simpler, altho not embodying the exact features of the idea shown in the illustration. For that reason we are doubtful if a patent could be obtained on the device.

WIRELESS 'PHONES NEAR, SAYS MARCONI.

Guglielmo Marconi, the inventor of wireless telegraphy, recently said that the United States heads the list of all countries in wireless inventions.

"A strange phenomenon is that the most progressive countries of Western Europe have not yet developed wireless telephones, while China, the most backward nation, daily uses the wireless telephone for communication between the cities and the rural districts,' Signor Marconi stated.

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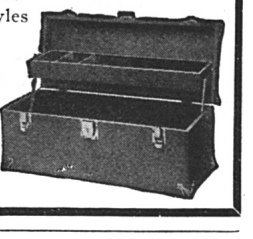

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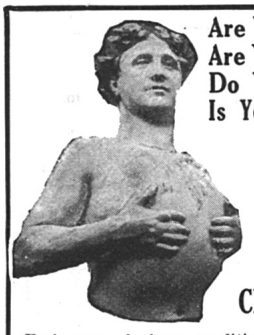

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The T Tube "Sub" Locator

(*Continued from page* 261)

ment was also used while the ship was *under way,* which was known as the "K" Tube. This usually trailed out of the immediate vicinity of the ship's propeller and wake in such a way that any unusual or suspicious sound was heard by the listening operator, at which time he would communicate the fact to the commanders of the "sub" chasers, who in turn stopt the ship and then made use of the regular "T" device, as the "K" tube gave only very approximate and unreliable sound indications.

From Fig. 1 the exact position of the "T" Tube may be judged. While the ship was under way, the "T" Tubes could not be used of course and were drawn up to an aperture specially made on the bottom of the ship in such a position as to be quite close to the ship's bottom; in fact, in a sort of flush receptacle specially made for the purpose. This prevented the "T" Tube from coming into contact with any possible foreign projections or other missiles which might damage or tear away the apparatus.

"T" Tube Tells of Submarine Suicides.

In one of his recent discourses on the part played by the American Navy in hunting down Hun submarines off the English coast and in other localities, Admiral William S. Sims has romatically related some startling facts little known to the world outside of naval circles.

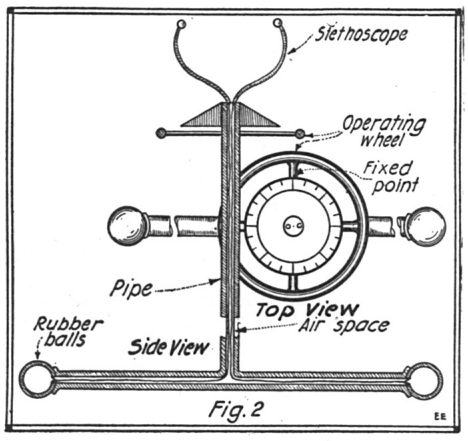
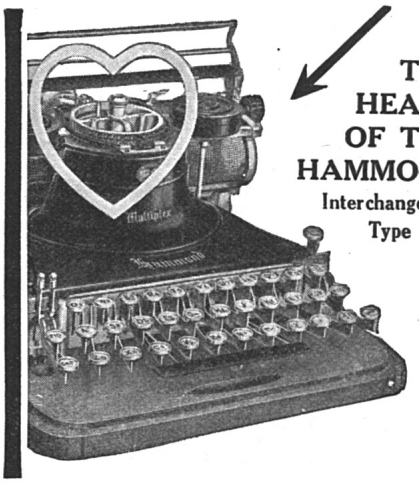


Fig. 2. Side and Top Views of "T Tubes"—Also Called "C Tube" By Naval Men,—In Which the Stethoscope Listening Tubes Lead Down thru a Pipe and Then Divide, One Going to Each Rubber Ball. The Rubber Balls Are Submerged In the Water and Are Very Sensitive to Any Sound Which May Be Transmitted to Them Thru the Water.

In one particular instance, and after a submarine had been chased after a considerable length of time, the closest watch failed to show any further movement of the enemy. Presently efforts could be detected by the ever listening "T" Tube operators on the part of the enemy crew to apparently effect repairs on the damaged U-boat, or else to try and get her propeller started; but after a few such attempts silence reigned again. But all at once a startling and unusual sound was heard by the listeners at the "T" Tube apparatus on the submarine chasers which were hovering in the vicinity where the German had submerged—it was nothing less than the sound of a revolver, and . . . before the listening sailors unglued their ears from the underwater sound detectors, they counted twenty-five shots. The answer was that that particular enemy sub-



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marine would never again attack Allied shipping, for it meant that the crew had found it impossible to navigate the craft in any direction, not even upward to the surface, presumably, for they had all committed suicide. Whether or not the crew found it possible to raise the submarine to the surface or not, but declined doing so in order to escape capture will always remain a mystery.

In Fig. 1 the method of signaling to other sub chasers the position of "spotted" enemy submarines is shown, and this is in the form of a large needle or arrow

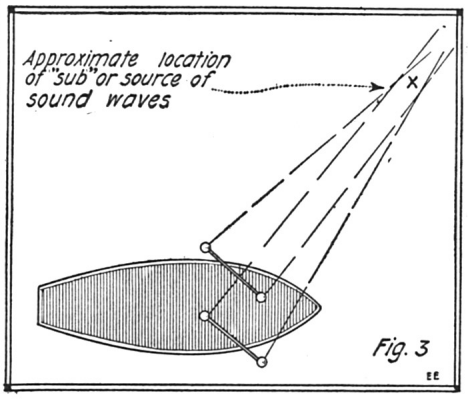

Fig. 3. This Diagram Shows How a "Fix" is Determined By 2 "T Tubes" On a War Vessel, As Indicated By the Cross. The Usual Procedure for the Submarine Chasers After Determining the Position of the Enemy, Is to Pass Over the Spot Where It is Thought to be and Let Loose With a Series of "Depth Bombs," Which Usually Finishes the Enemy Or Seriously Injures Him.

mounted thru a universal joint on a standard, erected on the top of the chart house of the submarine chaser; or in other words, upon the upper bridge. When a sub chaser spotted an enemy submarine, one of the officers moved this arrow until it pointed in the direction of the enemy. For this purpose the horizon was considered as divided off into a complete circle of 360 degrees, the same as a compass. When the arrow pointed directly upward or in a direction in line with the top of the mast, the geographical indication noted was north. When the tip of the arrow pointed at right angles toward the right, looking at the bow of the boat, the direction was east. Similar, the tip of the needle pointed downward for south, and at right angles to the left for west, with the usual intermediate compass points. The position of this arrow was read by direct visual operation thru a telescope or binoculars in the daytime, and at night its position was easily read due to the fact that the arrow carried a white light at the tip and a red light at the tail.

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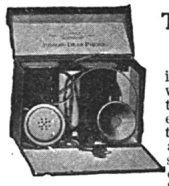

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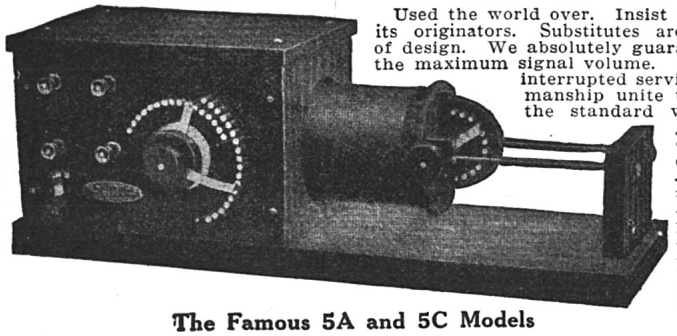

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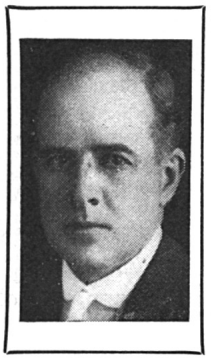

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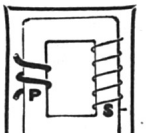

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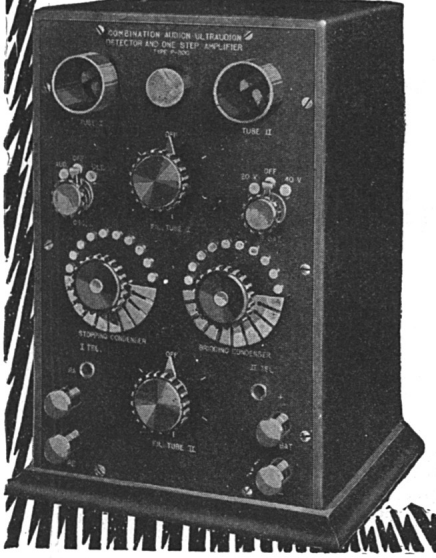

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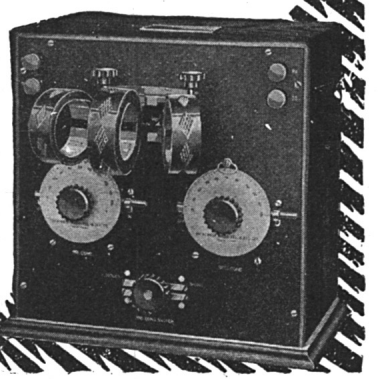

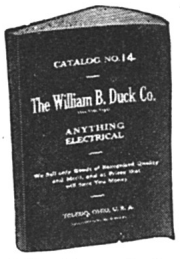

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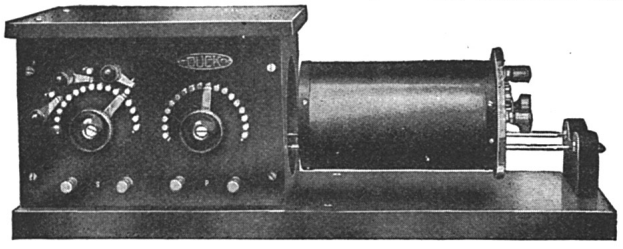

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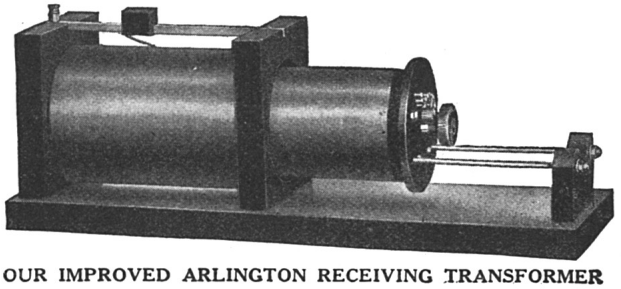

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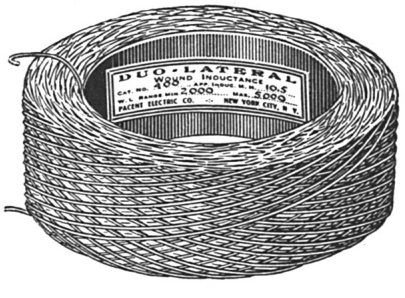

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Three Types of Amateur Spark Gaps

By PIERRE H. BOUCHERON

(*Continued from page 299*)

ner that each gap is made air-tight. When sparks occur between these very small spaces the gaps remain comparatively cool and the quenching effect takes place very quickly and effectively. Particularly is this true if the spark chambers are made *absolutely air-tight* and the draft of a small electric fan be directed upon the entire arrangement.

This type of gap usually consists of a number of flat copper or bronze discs separated by so-called *gaskets* or *insulators* consisting of either mica or specially treated paper compositions. These discs and insulators are arranged in a trough and comprest together by means of a clamping lever. Each gap unit may be spaced from 1/50 to 1/100 of an inch. In general practise it is customary to allow approximately 1,200 volts for each 1/100-inch gap section.

Altho the gap will work much more effectively on higher frequencies, it may be arranged to give fairly good results on a 60-cycle supply source as well as with spark coils of any size. Such use, however, necessitates careful adjustment of a reactance coil which must be placed in the primary circuit of the transformer. When employing the quenched gap, less condenser capacity is required than when other gaps are employed. Two decided advantages are: the *decrement* of a transmitter is considerably decreased and the gap is practically *silent* while in operation.

Fig. 3 shows the construction details of a quenched gap suitable for amateur use. The base is made of slate, bakelite or hard wood and is 10 inches long, 6 inches wide and about ½ inch thick. If procurable, a cast-iron base would, of course, be preferable. Each pedestal forming the trough may be in the form of pieces of cast iron or steel 4½ inches high, 2 inches wide and ½ inch in diameter. These two are separated at a distance of about 7 inches and fastened to the base by means of No. 10/24 machine screws.

A, B and C of Fig. 4 show cross-sections of three sparking discs suitable for this work. In order to secure good results with a gap of this type, it is very necessary that these discs be properly and accurately constructed. If possible it is suggested that the work of grinding and milling be done by a machinist. Better yet, some radio supply houses are in a position to furnish these plates direct to the amateur. The plates should be about 3 inches in diameter, ⅛ inch thick and have a sparking surface of 1 inch, and a gasket surface of ¼ inch as shown at C of Fig. 4. D of Fig. 4 shows a front view of one of the spark gap discs with suitable explanations.

The gaskets or washers which are used to separate the metal discs should have an outside diameter of 3½ inches, an inside diameter of 1½ inches and should have a thickness of from 1/32 to 1/64 of an inch. These washers should be made up of any insulating composition and probably can be bought at approximately the required size. In order that they be the means of effecting an air-tight joint between the plates when clampt together, these washers should previously be soaked in some mixture such as paraffin or varnish.

When the plates and gaskets are placed between their respective end pieces and arranged in the trough, the pressure adjustment handle is twisted until all gaps are prest tightly together. When a spark has taken place within a gap for a short time, the heat will cause the insulating mixture

on the gaskets to melt slightly, thereby filling all possible grooves so that the gap will be absolutely air-tight. To insure this an extra turn or two of the clamping device should be made while the gap is warm. The number of gaps used under any given power condition may be easily varied by means of an adjustable clip similar to the one shown at E of Fig. 4.

In building small experimental quenched gaps, the writer has often used an ordinary clamp of the type shown at F, which may be purchased at any hardware store for a small sum. This can be of the 5 or 7-inch variety. In fact, this clamping arrangement has proven excellent, the only fault being that the thread on the clamping lever is rather coarse and does not permit of a fine pressure adjustment. It can be used, however, to good advantage if the experimenter does not wish to go to the trouble of constructing the arrangement shown at Fig. 3, and particularly for small gaps employing four or five units suitable for spark coil work. As a matter of record many amateurs have constructed quenched spark gaps by employing several pennies or ten-cent pieces, separated by mica washers of slightly larger diameter and clamping the whole arrangement together in a suitable manner.

And now for a word of advice. Except for the dimensions of the quenched gap discs which must be accurately milled to produce good results, it really is not necessary that the experimenter follow the exact dimensions given for these three spark gaps. For instance, there is no reason why he should not use No. 8/32 screws if he does not happen to have No. 10/24 screws on hand. Where, however, it is a matter of strength, it is of course better to employ screws of larger diameters. These general directions may also apply to the various sizes of bases, pedestals, rods, uprights, etc. Unless one intends to construct a finisht product of commercial appearance, it is often more practical and certainly less expensive to make use of material and parts on hand than to purchase ones of exact stated dimensions.

Another word of advice is that if the experimenter intends to do very much apparatus construction work, it would be well for him to purchase reliable tools as the need occurs for them. In fact, it is almost impossible to build anything very exact without having a hack saw, a hand drill, a full set of drills, taps and dies, suitable for the construction of small instruments. A small foot-power lathe will be found to be a most welcomed member of the experimenter's tool family.

Alarm Number 18

By CHARLES S. WOLFE

(*Continued from page* 266)

them are there with their eyes glued on that box we get an alarm from 74. Now they all admit they haven't the faintest idea of who is doing the thing, or how he's pulling it off."

"Let's see," Fenner said, thoughtfully. "You have to have a key to open those boxes, don't you? If my dope is right, the keys are in the hands of trustworthy citizens who live in the neighborhood of the box in question. Have any of them been asked for their keys?"

"No," retorted Davidson, "They haven't. My own opinion is that the scoundrel who is sending these alarms in has found some way of striking the alarm by tampering with the wires where they lead into the box."

"No," demurred Fenner, "I don't think so. About the only way that could be done would be to get above the box and short circuit it. The person who did that would

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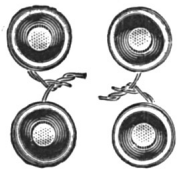

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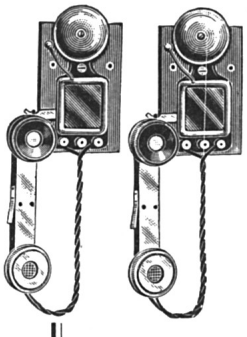

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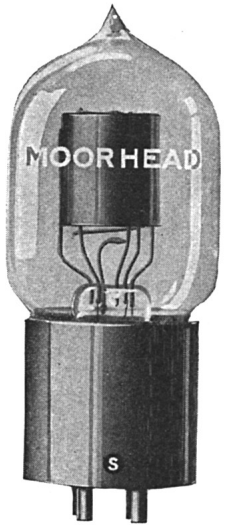
have to hang there long enough to send four rounds, and in that time he'd be bound to excite suspicion. Don't think much of your theory, Chief."

The exasperated man threw up his hands in helpless rage. "All right!" he roared, "Get a better one then. You are the electrical brains of this place. Go get me this whelp. And for God's sake get him quick. Do you realize what this thing means? It's demoralizing the department, that's what it's doing. The firemen are getting to the point where they don't care if they answer a call or not. They figure that it's a fake before they start, and they are taking their own sweet time about getting out of the house. I saw number eight truck go by here about an hour ago. If it hadn't been for the paint and brass work you'd have sworn it was a sight seeing bus. First thing you know we'll get a real fire and it'll get away from them before they reach it. I tell you Fenner, it's got to end right now, and you are the chap I'm counting on to end it. Get out! Get busy! Do something. If you need help, telephone me, and I'll send you a whole regiment. Hop to it! Shoo!"

Outside the building Fenner looked at me and whistled. "Now what do you think of that?" he asked, "Rather a large order, isn't it? Pick out the one chap in a whole city who is amusing himself by calling the wagon and pick him out *pronto!* Davidson must think I can hop in and out of the fourth dimension at will."

I saw that he was about half sore, and decided that the best way to sooth him was to secure action of some kind quick. So I lead off diplomatically. "Well, where do you propose to begin your campaign?" I asked. "Let's find out what box was pulled last, and look it over for suspicious markings."

"Such as what?" demanded Fenner, still



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nettled, "Bloody finger prints, death's heads? Something of that sort?"

"No," I replied, cheerfully, "But it occurred to me that if some one was shorting these boxes we might find some bared insulation, or something of the kind to give us an inkling of how this bird is doing his stunt."

"There is no earthy use of going near any of these boxes," said Fenner, decidedly, "For as I told Davidson, the man who sends an alarm from any box can only do it with the necessary speed by opening the box and pulling down the handle in the regular way. To cling to the post on which the thing is fastened and patiently make and break the circuit would be bound to be fatal to the simp that tried it. Somebody would be bound to see him at it. Whoever is doing the sending is not working from any box. He has tapt the line somewhere in an out of the way quarter, and is turning in these alarms from one spot only. You can bet on that. And about the only thing that I see to do is to follow up each circuit until we find the tap. That's some job."

We wandered along with the crowd rather aimlessly, each busy with his own thoughts, vainly trying to find a starting point for our work.

Finally I broke the silence that had fallen between us. "Why does a person do this sort of thing, anyway?" I asked, "Why cause all this excitement for no reason at all? If it was getting somebody something I could understand it. But no one seems to be ahead on the transaction. There doesn't seem to be any motive for the thing at all."

Fenner laughed shortly. "For fun, I guess," he said, "Likes to watch the engines whiz by."

Then he brightened suddenly, and grasped my arm. "Which gives me the first real idea I've managed to think of since we left Davidson. Let us assume that this bird turns in alarms just for the pleasure he gets out of seeing the apparatus on the jump. All right. To avoid suspicion, he doesn't send in one number repeatedly, he jumps all over the city. This effectually prevents attention from being drawn to one locality. But—as each different number calls the apparatus over a different route, it stands to reason that he misses his fun about nine times out of ten, unless——"

"Unless he has some means of sending in that alarm from the spot he happens to be standing on at the time," I interrupted. "And that spot might be anywhere in the city limits at any time."

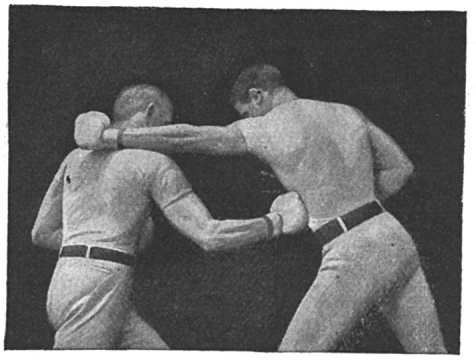
"Not on your life, young fellow," retorted Fenner. "This lad has no pocket fire alarm set, take it from me. He's located. And he must be located some place where he can see every response, granting that he goes to all this trouble in order to watch the apparatus travel. Now, in general, there is only one place where that spot could be."

"I don't follow you so well," I said, dubiously.

"Why, imbecile, there is only one spot that the engines are bound to pass no matter what route they take, and that is the block in which their engine house is located. At last we are getting somewhere. Once we find out how many companies there are, and where each is located we've got our hunt narrowed down nicely. Sounds reasonable, does it?"

"I have to admit that it does," I said, grudgingly, "But there are enough companies to keep us busy for a week. And Davidson wants action."

"Well, he wasn't getting so much of it when we left, was he? He'll just have to wait until we wade thru a bunch of elimination tests. I've got all that dope at home. Let's go out to the house and find out how many companies we have and where they are located."



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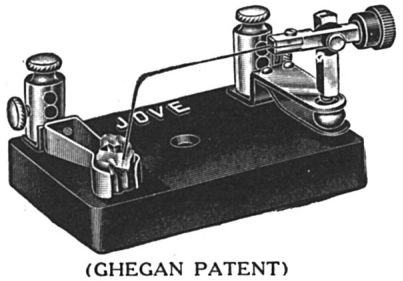

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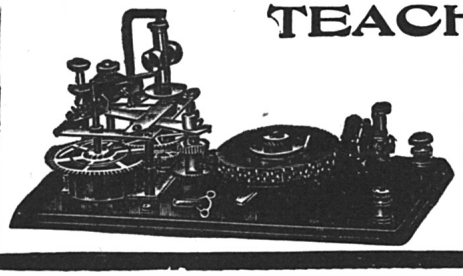

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"I hate to look at that list," I grumbled, as we boarded the street car. "When we get the total number of fire houses in this village, something tells me we are going to realize what a nice, sweet little task we're in for."

"Maybe so, and maybe not," said Fenner, calmly, "In the first place, I think the list of likely houses will amount to about six."

"How do you arrive at that conclusion?" I demanded. "I don't see much pick among them. One house is about as good as another when it comes to guess work, and that's what we'll be up against after all."

"Not so much real guess work after all, because I'm taking the view that every engine house that's located on a corner is not as likely a place to look for our playful friend as one that's situated in the middle of a block."

"Just why?" I wanted to know.

"Well, because a house located on a corner would not cause its apparatus to pass a given spot as often as one located between corners," replied Fenner. "Granted?"

"I guess so," I retorted. "Altho it seems like a slim chance to me all around."

"When you are looking for a needle in a hay stack your chances are slim. Can you suggest anything more plausible?"

I had to admit that I couldn't and so when we arrived at Fenner's home we noted down the number of fire stations in the city, and their location. We found that there were some twenty-five companies, only six of which were located between blocks. This fact caused Fenner's spirits to soar.

"My boy," he exulted, "Unless I miss my guess we will never have to look up one of the remaining nineteen. I have a hunch that the culprit is living close to one of these six, and now I'm going to try to narrow that down some."

"How?" I asked, mystified.

"Watch your uncle," was his retort, as he reached for the telephone. He called the number assigned to our City Hall, and got Davidson on the wire. I heard him ask for a list of the numbers of all the boxes from which the fake alarms had come, and then for several moments he was busy jotting down the information that was coming to him over the wire.

When he had hung up the receiver, I grinned at his scowling face. "The whole seventeen?" I asked, indicating the pad that he held in his hand.

"The whole twenty," he corrected, gravely. "We've been having some more wild goose chases since we left the hall, and Davidson's anger has reached the Nth power. He threatens to discharge all the plain clothes men within the next twelve hours unless the guilty party is brought before him so that he can rend his flesh. Davidson's entire being seems to be yelling for gore. Let's make some time, fellow, I want to look these fire houses over before dark, if possible."

"Thought you were going to narrow those six down to something less," I reminded him.

"Right," he said, "But I can do that as we walk along. There's no secret about the process. I'm going to look up the location of these boxes, and any house that would send an engine to every alarm that has been turned in will be the object of our first visit. You see, all engines don't go out on every alarm. The city is districted. I'm still working on the theory that it won't do any one any good to turn in an alarm unless he can see the smoke wagons fan."

"Great stuff!" I applauded. "Let's look over a list of box locations."

This busied us for a time. Finally, out of our researches we reached the following conclusions. First, that the various alarms which had been turned in came from boxes whose locations were so widely differing that any attempt to deduce evidence from

the facts was useless. But second that engine company number eight would have been called out on every alarm except two. As Fenner said, enough was sufficient, more especially when you took into consideration that number eight's quarters was one of the between block locations.

Shortly afterwards we were strolling apparently aimlessly up the block toward number eight's station. Both of us were scrutinizing closely the wires strung from the cross arms of the poles along the street. We easily located the alarm wire, but two or three turns up and down the square failed to reveal any suspicious leads branching into any dwelling or store along either side of the street.

Fenner grew disgusted as close scrutiny failed to yield us anything of value, and we eventually blew down to number eight where he introduced himself to the captain. This individual was in none too good humor, and it took much diplomacy and a 'phone call to Davidson to secure us the necessary liberty around the place.

The good captain was highly incensed at the wave of false alarms that had swept over the city. I imagine he was a rather good natured chap when things were right, but the last couple of days had badly strained his disposition. He commented picturesquely on the happenings of the last forty-eight hours.

"Wild goose chase after wild goose chase," he grumbled. "Every time the gong rings it's another senseless run. Believe me, if I ever lay my hands on the lu-lu that's making a plaything out of the system he'll think all Hell's a-popping. A joke's a joke, but this business of sending overworked firemen out at any old hour is too much of a good thing. And the worst of it is that we get pretty nearly every alarm here."

At Fenner's request he led the way to the roof of the building, and once alone we began operations. Taking our field glasses, which we had brought along for the purpose, we stretched ourselves near the edge of the roof and carefully scanned every foot of the wiring along the block. The glasses brought things so close that we might as well have been on the poles themselves, but the closest scrutiny failed to reveal any tap in the alarm wire.

Fenner was rather disappointed, for, as he confest, he confidently expected to find a tap of very fine wire some place along the street.

I spied the aerial first. To ease the strain on my eyes, I had lowered the glasses, and was gazing out over the roof tops. There was a typical amateur outfit a few roof tops down. I nudged Fenner. "Look," I said, "There's an interference factory. A lot of the Q. R. M. we get around this burg originates there, I'll bet. Bet you it's a one inch spark coil."

And then, remembering the *Educated Harpoon,* I added, "Couldn't be that that kid is sending in these alarms by wireless, could it?"

Fenner grunted. "It could—not," he growled. "This fire alarm system is a closed circuit affair, son. When you send in an alarm you shut off the juice instead of turning it on. That allows the armature of a relay to fall back and close an alarm circuit. Short of a ton of apparatus rigged up on one of these poles, your young friend over yonder couldn't start anything with his ether plow."

And then I saw his face change. "Good night," he muttered, "I wonder!"

"You wonder what?" I queried.

"Let me alone a moment, Bill," he replied, "I want to think. Look at the birdies or something."

For a long time he lay there silently. I began to grow impatient. Then he suddenly began to laugh.

"What's so funny?" I demanded, nettled at this unseemly display of mirth. "Tell

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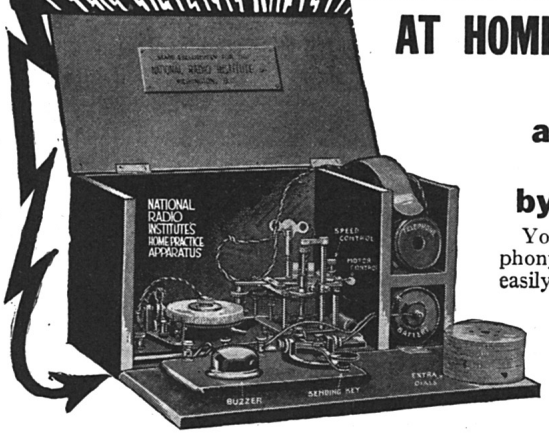

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ROTARY GAP

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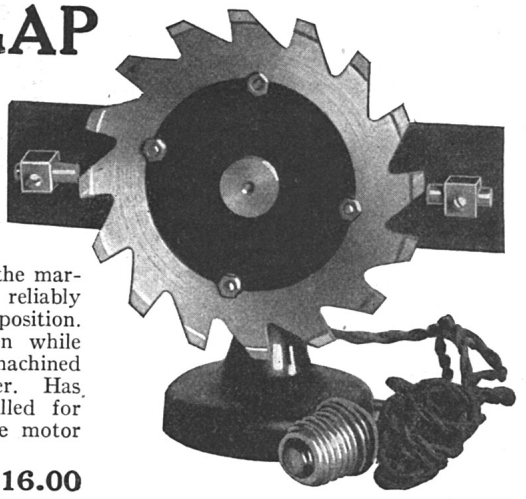

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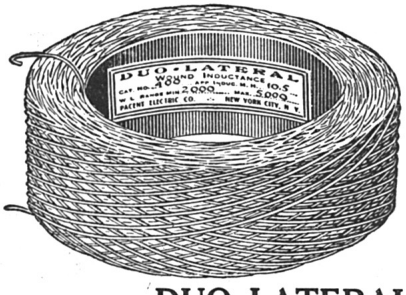

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me when it's time for me to begin and I'll join you."

For answer he sprang up and headed for the trap door leading into the fire house. "Come on, Bill," he called over his shoulder, "Come on and I'll try to catch the wild goose."

"What wild goose?" I panted, as I followed him down the steep ladder, "Who's a wild goose—what's a wild goose?"

"Why that wild goose that the captain and his men have been chasing for so many hours."

He past rapidly thru the station house, and out onto the street. There he vouchsafed a little information. "We are going to call on our brother amateur," he said, "And please try to look innocent. Right now you remind me of Dr. Watson."

We knocked at the door of the house on which we had seen the aerial. A young chap of about fourteen came in response. Fenner grinned amiably. "We would like to see the young man that has the wireless set," he said, cordially: "Is he at home?"

"That's me," said the lad. "What do you want?"

"I've been thinking about getting into that game myself," said the not too truthful Fenner, "And when I saw your aerial I thought maybe you might be able to give us some pointers."

Instantly the kid thawed. "Come in," he invited, "I'll show you my set. Got some pieces of stuff around here from when I was learning, maybe I can sell you. That was before I got my big set."

I had visions of a quarter inch spark coil. The boy led the way upstairs, talking over his shoulder. "Used to use a coil," he said, "'till dad got the juice in. Then I got a transformer. Current's direct, tho, and I have to use an interrupter."

I got a violent nudge from Fenner just then altho I didn't see that anything very significant had turned up so far. We were ushered into the boy's room, where a rather shabby old loose coupler, an erratic crystal detector of uncertain vintage, and a pair of fairly decent 'phones were doing duty as a receiving set. Fenner, the rogue, profest ignorance of the functions of all the junk laying around, and soon had the kid delivering a regular lecture, which was a scream.

Finally, conversation lagging a little, the boy dropt into the chair in front of his apparatus, his fingers closing idly over the key. As Fenner put questions at him, he kept drumming away on that heavy old key until it began to get on my nerves.

Suddenly the quiet of the neighborhood was broken by the wailing shriek of a siren. A clamor arose below us in the street, as with bell clanging and siren screeching, number eight roared by in answer to an alarm.

Instantly the youngster was on his feet and was leaning half way out the window. "There she goes," he yelled over his shoulder, his eyes burning feverishly, "Lord, how that fellow does beat it."

He watched until the speeding engine turned a corner and was lost to sight. Then he turned to us in the room, his eyes still full of boyish excitement. Fenner was regarding him quizzically. "Yes," he said, gravely, "There he goes to box number 18. But you are going along down to the police station with me."

The terror in the boy's face was pitiful to see. In vain he denied, pleaded, begged. Fenner was iron. "Down you go," was his ultimatum, "You can tell your story to the chief."

At that the poor kid went to his knees in a perfect frenzy of terror. "No, no," he wailed, "Don't take me down there. I'll admit that I did it. I'll do anything for you if you'll let me go. I'll promise I'll never

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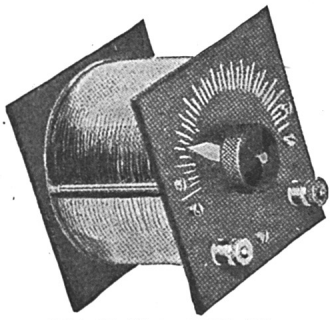

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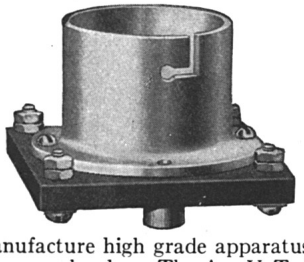

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do it again. I only did it for a little fun—honest! Please don't arrest me!"

"Brace up, kid," said Fenner, "Not for the world would I let you off. Down you must go and tell the chief what you've been up to. But I'll do my best to have him let you off. Come now. Don't let your folks see that there's anything wrong yet, and maybe I can get you out of this scrape."

With a mighty effort the boy got himself together, and a half hour later we led him, white faced and trembling before Davidson. For a long while Fenner and the chief whispered together at the desk. I couldn't catch what was said, but from the scowls that Davidson shot at the kid and the earnestness of Fenner, I judged that my friend was having his hands full in securing clemency for the lad.

Finally the conference broke up. Fenner came to me and took me by the arm. "Come on, Bill," he said, "Let's go."

Mystified, I moved reluctantly towards the door. I saw Davidson slowly unloosen the leather belt from around his waist, saw him seize the unfortunate youth and draw him across his knee. We shut the door behind us. The case was being *settled out of court!*

Once on the street, I turned to my friend. "And now," I said, "Would you mind giving me a little idea of what this is all about. I didn't see that kid do anything out of the way. I don't see how you caught him, or how he did the trick. Slip me the dope."

Fenner laughed. "I thought you mist it," he said, "It was a slick trick the kid was getting away with, all right. He sent that alarm in while you were looking at him, and you never tumbled."

"He did?" I said, blankly, "With what?"

"With his telegraph key," replied Fenner, calmly.

"How?" I asked, "by wireless?"

"Not the kind you mean," chuckled Fenner, "Not with the set. But by wireless, nevertheless. He used one side of the telephone circuit. It runs right alongside of the alarm wires on the pole. You've heard of that cute little phenomenon called induction, haven't you? Well, that's what he put over. He used direct current. *He induced a counter E. M. F. in the alarm circuit of the same value as the current flowing there.* Result, zero current in the alarm circuit every time he pusht his key. Back dropt the armature of the relay, closing the other circuit, and in went the signal. He used a resistance to reduce his current rapidly and yet gradually to zero. This prevented another pulse on the alarm circuit when his current went off. Thus he prevented double signals, which would have advertised the fake. Once he got everything nicely adjusted, he had the city fire alarm system at his mercy. Pretty clever for a fourteen year old, eh?"

"Holy Smoke, I'll say so," I gasped, "How did you get onto the stunt?"

"More good luck than good management," replied Fenner, "When you showed me that aerial it set me to thinking. I knew that he couldn't turn in an alarm with a regulation set, and I began to ponder over the different methods by which the trick could be turned. It dawned on me that you could induce a current in that system, and it also struck me that the only person in the neighborhood who seemed to have any knowledge of the laws of electricity was the owner of that aerial. Then I took a chance, and happened to hit it. At that, if he'd have left that infernal key alone, I wouldn't have been sure. But I sat there and counted the alarm as he turned it in. Then I knew that I had caught the captain's wild goose."

"Some stunt," I commented. "I'm glad they didn't do any worse to the kid."

"So am I," admitted Fenner. "I like to see that gang going myself. Let's go and try out that circuit you picked up."

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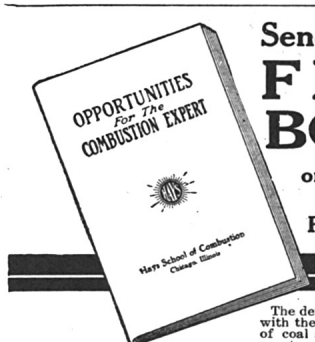

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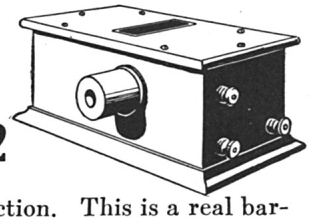

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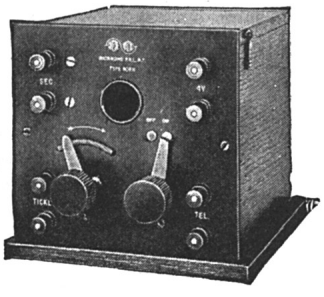

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The Story of Glass

By PROF. FLOYD L. DARROW

(*Continued from page 269*)

Defeat was not written in their vocabulary, however, and they persisted in spite of every obstacle and adverse circumstance. Then came the World War and with it, the importations of optical glass from Europe ceased. Something had to be done and what had before been only a highly desirable goal, at once, became a necessity and a patriotic duty! After three years of diligent research, interspersed with temporary failures, the Bausches succeeded in making optical glass of a very high grade.

When the United States entered the war it became imperative that the Government should have large quantites of glass for purposes already enumerated. Immediately the Bureau of Standards and the Geophysical Laboratory at Washington took up the problem and Major F. E. Wright, Ph.D., was assigned to take charge of the work. In addition a number of glass manufacturers thruout the country placed their plants at the service of the Government.

DIFFICULTIES OF MAKING OPTICAL GLASS.

For good optical glass there are six fundamental requirements: (1) Correct optical and physical properties; (2) freedom from striae; (3) freedom from bubbles; (4) high light transmission; (5) freedom from strain. The skill and machinery to meet these requirements did not at that time exist in this country. There were needed a stirring device that would eliminate the striae, or tiny grooves, melting pots more resistant that corrosive fluxes and freer from iron and sulfur than any then being made in the United States, and the purest batch materials. Most essential, too, were skilled workmen, of whom, as already stated, there were none in this country at that time. But with characteristic American enterprise and as the result of an amount of technical and practical experimentation unprecedented in the history of the glass industry, these conditions were quickly and successfully met.

The most insidious foe of pure glass is iron, which is always present in sand, the one fundamental ingredient of every kind of glass. To free the sand of this troublemaker a huge electro-magnet is past over it. This removes all but traces of the iron and then the sand is washed with acid and water. In glass for other than optical purposes the iron is not so carefully removed but the green color, which it imparts, is neutralized by the addition of manganese dioxid. The reddish tint of the latter constituent neutralizes the green of the iron.

HOW OPTICAL GLASS IS MADE.

The first step in the manufacture of optical glass is to preheat the clay pot for a *period of seven days* to a temperature of 2,500 degree Fah. Then into this are weighed at intervals of fifteen minutes for one hour cullet, i. e., optical glass of an inferior quality from a previous melt, in lots of 100 pounds each. This is followed with pure batch materials in successive lots of 400 pounds, each at intervals of two hours, accompanied by hand stirring. The mass is then machine stirred for four hours, after which it is removed from the furnace, covered with earth and allowed to cool, or anneal, *slowly for four days.* And it is right at this point that the most critical part of the whole procedure comes. *The resulting product should be structureless, perfectly uniform and absolutely free from crystallization.* If crystallization or "devitrification" as it is called, sets in the glass will be ruined for optical purposes. This condition will result from the too slow cooling and gives rise in the body of the glass to a

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4 West Park St. Newark, N. J.

large number of beautiful crystals of a mineral known as "Wollastonite." At other times this devitrification manifests itself in the formation of very small crystals of some one of the mineral ingredients and renders the glass dim or opaque. The only remedy for this condition is more rapid cooling and occasionally this process must be artificially hastened by playing a stream of water over the pot of glass as it is removed from the furnace. Another cause of this devitrification of glass is the solution and subsequent crystallization of small portions of the melting pot itself, for molten glass is one of the most corrosive substances known to science. This last source of trouble, however, may be eliminated very largely by proper stirring.

After the glass has cooled sufficiently, the pot is broken away and the chunks of glass are sent to the examination room. All portions not having the qualities of good optical glass are sent back to be used as cullet for another melt, while the good glass goes to the press room. In the press room the chunks are slowly reheated until soft, and then prest into slabs in powerful hydraulic and pneumatic machines. They are then annealed and laid in frames on a grinding table covered with fine sand or emery and ground to a smooth surface. The polishing is accomplisht by driving to and fro over their surfaces an iron block covered with felt and rouge. Rigid inspection for striae and bubbles follows. The latter are detected by looking thru the slabs toward a dark cloth, while a narrow ray of light enters the glass at right angles to the line of sight. Defective spots are marked and removed by sand blast. All accepted glass is reheated, prest and very slowly annealed.

GRINDING AND POLISHING.

Of all the manifold uses to which glass is put there is none that requires so many hours, and even months and years, of painstaking work as the grinding of lenses. After the glass maker has done his work and succeeded in producing glass of perfect optical qualities, this labor may all be brought to naught by lack of skill in grinding. While we cannot describe here this most important work, it may be pointed out that the giant Yerkes refractor, the largest telescope lens in the world weighs a half a ton and *required two and a half years* for the grinding at a cost of $125,000. The block of glass for the big 36-inch refractor of the Lick Observatory was poured at the Paris glass works twenty times, with a month consumed after each pouring in the *annealing,* before a satisfactory product was obtained. The manufacture of camera lenses, too, has become a highly specialized art, as rigidly exact and painstaking as the making of a large refractor. So large must the output of these lenses be that much of the hand grinding and polishing has long since been superseded by motor-driven machinery. Incredible as it may seem this grinding is carried to an accuracy of *one fifty-thousandth of an inch.* In the objective of a compound microscope there are six lenses, the smallest of which is only one-sixteenth of an inch in diameter. The machinery for grinding it is a marvel in itself, and the grinding is done by trained technicians who have worked at the art from boyhood. By the sense of touch they are able to determine the progress of the work, and the finished product must be as perfect as the largest refractor.

The requirements imposed by the treatment to which *chemical glassware* must be subjected are rigid in the extreme. It must be thin so that the unequal heating of inside and outside in breakers and flasks will not cause breaking. It must have a higher melting point than has ordinary glass. It must be able to resist the corrosive action of strong acids and alkalis. For these reasons potash is substituted for soda in its composition and being of higher melting

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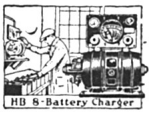
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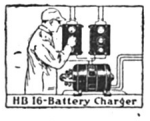
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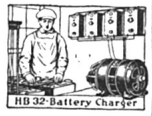
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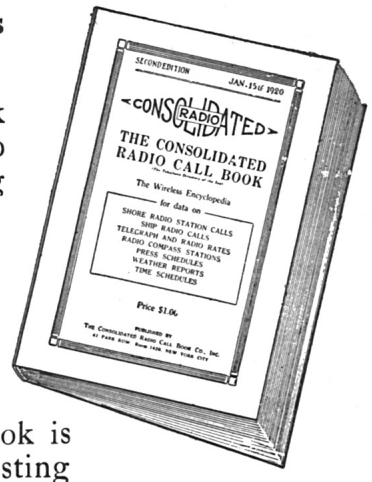

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point it is more difficult to blow. Some of the most skillful work of the whole industry is to be seen in the marvelous facility with which these genie of the blowpipe fashion the many intricate and often delicate pieces of chemical apparatus. Formerly this glassware was all made in Europe, particularly at Jena, Germany, long famous for the superior quality of its chemical glass. But the War has changed all this and we now make in this country glass in all respects *better* than what was imported in former years.

PLATE AND WINDOW GLASS.

Plate glass is *machine made.* In huge furnaces the melting pots are heated and when the melt is ready a traveling crane seizes the pot and pours its molten contents upon a casting table, consisting of a cast iron plate over which is suspended a heavy iron roller so adjusted that it may be set at any desired distance above the table-plate. After it has been rolled to the proper thickness the plate of glass is transferred to the annealing oven, where it slowly passes thru a long tunnel heated to a high temperature at the starting end and gradually cooling to ordinary temperature at the other. It is removed from the oven and cemented by Plaster of Paris to a large revolving table where it is ground at first with coarse emery dust, then with finer material and finally it is polished with mechanical rubbers covered with felt and iron oxid.

Window glass is now blown by machinery into huge elongated cylinders until the walls are of the proper thickness and then it is cut lengthwise and flattened out in a flattening furnace. The cutting is done by stretching along the glass a small iron wire and passing thru it a current of electricity. This heats the wire to incandescence and the glass breaks along the line. Bottles are blown to shape in molding forms. So, too, are lamp shades. Glass is frosted either by immersion in a solution of hydrofluoric acid or by directing against it a blast of sand, by the force of comprest air.

The color of glass is due to the presence of small quantities of metallic oxides. Cobalt gives blue. Iron and chromium give green and cuprous oxide or metallic gold produce ruby glass. The gold is present in the form of small metallic particles thoroly disseminated thruout the mass. With the very intense light and high magnifying power of the ultra-microscope these infinitely small particles stand forth like glistening points, and are seen to move to and fro in zig-zag paths with a very rapid motion.

In former years the glass industry in this country was governed very largely by the "ancient rule of thumb" but every glass plant now has its chemical laboratory and has come under the sway of the finger of modern Science.

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Music was transmitted half a mile by radio and was sufficiently loud at the receiving end for dancing, according to announcement from the University of Pittsburgh, which, with the Carnegie Institute of Technology, conducted the experiment.

The Tech orchestra sat in Central Hall and played a jazz tune, while the Pittsburgh University students gathered in Heinz House, half a mile away, and danced two numbers. Prof. Edwin R. Rath at the experiment station of the university transferred the music by the use of a Magnavox and two strings of electric wires.

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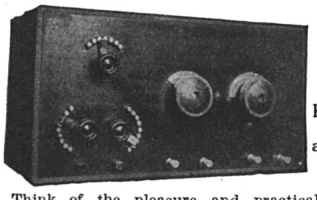

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READ THE CLASSIFIED ADDS ON PAGES 348-351

Shafts of Light Regulate Street Traffic

By EDWIN F. LINDER, M.E.

(*Continued from page 256*)

Having brought both vehicles and pedestrian transit to a stand-still, he now opens up traffic for automobiles going east on the "Avenue." To accomplish this he presses the "white D" button which operates the mechanism in such a manner that it moves the ruby glass wing and leaves the searchlight beam *exposed;* thus projecting a white beam from the head of the column D; thereby giving the right of way to the eastbound traffic on the south side of the "Avenue." At this time other traffic is stopt at the three other points A-B and C.

Having gained control of the situation the officer desires to permit the people to pass on foot from A to C and from B to D, while the vehicles are moving in both east and west directions along the "AVENUE." To give the proper signal, he allows the ruby glass to remain over the searchlights at A and B, pushes the "white C" button, thereby giving the "clear" signal to west bound traffic on the north side of the "AVENUE."

The same method is used for controlling the north-bound and south-bound traffic on the "STREET," of course in order to give the proper signals the officer must operate the switches controlling the mechanisms for that purpose.

It can readily be seen that in the event of an emergency, demanding the immediate halting of all traffic, such as clearing the passages for fire-apparatus or ambulance service, the projecting of all four shafts of red light at the same instant would be so conspicuous that they *could not escape detection* by any one, even tho a mile away. It would also give ample notification to the officers at the intermediate posts between such busy traffic signal stations to prepare for the on-rushing fire engines by warning people to keep on the sidewalks.

The Aurora Borealis

By PROF. LINDLEY PYLE

(*Continued from page 255*)

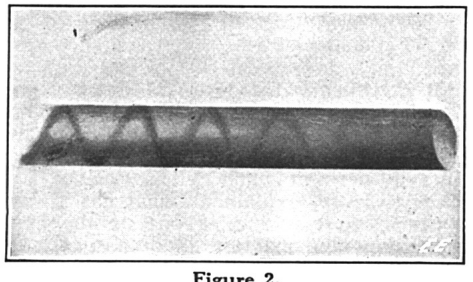

Figure 2.
Spiral Formation of Cathod Rays in a Uniform Magnetic Field Where the Lines of Force Are Oblique to the Direction of the Emission of the Rays.

of trajectories in his own theory, calling attention to the fact that his positively charged particles will turn around the magnetic axis of the earth in the opposite direction—in his own words, "paths of positively charged particles are the mirror image of the negative ones with respect to a plane thru the sun and the magnetic axis of the earth." The positively charged alpha-particle has much greater mass than the negatively charged cathode ray particle; it is deviated less by the gases it penetrates; and it has other properties differing markedly from those of the negatively charged particle. Vegard feels that the positive particle theory gives a simpler explanation to auroral forms, especially the drapery structure, than does the negative particle theory. Very possibly the ultimate theory will be an amalgamation of these two. Possibly

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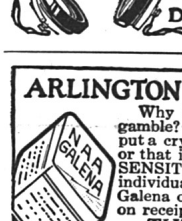

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charged particles may be operating whose nature may be as yet unfamiliar to us, since there seem to be well authenticated cases of auroral rays penetrating the atmosphere to within a kilometer of the earth, or roughly two-thirds of a mile. This corresponds to a luminescence-producing radiation more extreme than any that has yet been observed in any laboratory experiment.

Incidentally the aurora gives interesting information regarding our atmosphere in that Lenard has shown that auroral displays at a height above 300 kilometers (say 200 miles) indicate the presence there of gases of very small density such as helium and hydrogen. This checks certain trustworthy calculations of the composition of

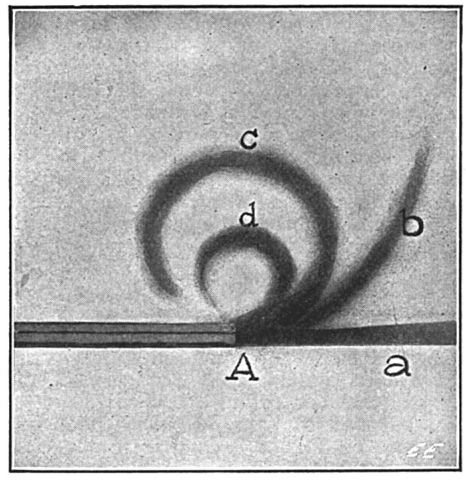

Fig. 1

Spiral Movement of Cathode Rays in a Uniform Magnetic Field Perpendicular to the Direction of the Emission of the Beam. A. Cathode Consisting of an Aluminum Wire Exactly in the Opening of a Small Glass Tube Giving a Very Fine Pencil of Rays. a. Pencil of Cathode Rays Before the Magnetic Field Has Started. b, c, d. Three Different Circular Spirals of the Rays for Three Different Values of the Magnetic Field.

the atmosphere at varying heights in which there has been found a thick layer of practically pure hydrogen at a height of over 60 miles. Störmer's study of the long and faint auroral rays in this hydrogen layer enabled him to compute the probable temperature thereof—a temperature of approximately—175°C., nearly 300° Fahrenheit below the freezing point of water.

Surely in the face of the checking of experimental and observational evidence with theoretical deductions we cannot but accept the theory that auroral displays are closely connected with an electrified emanation from the sun. Certain details of the theory need further development, but that time is near at hand when Science can claim to have "explained" what has always appeared to mankind as one of the most mysterious and magnificent of natural phenomena.

Triple Camera Photos Lightning Flashes

By ALFRED GRADENWITZ

(*Continued from page 259*)

By comparing the third view with the two stereoscopic pictures, the main flash of lightning is found to coincide with less than 0.001 second with the last partial discharge of the hindmost cloud lightning, thus proving with nearly absolute certainty an *electrical connection* between two discharges entirely independent in space.

LIGHTNING FLASHES NOT INSTANTANEOUS.

These researches proved especially valuable as a means of ascertaining the origin of the paths of lightning flashes. Similarly as an electric spark, a lightning flash, as a rule, is not produced instantaneously, but is

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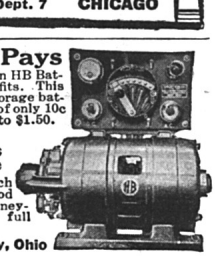

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started by several brush-like "preliminary" discharges, following up one another by jerks. This was strikingly illustrated by Walter's triple-camera lightning flash pictures. In one case the preliminary discharges of three branches were found to have occured 0.00885, 0.00795 and 0.00569 second respectively, before the main discharge, so that the total time of production of the lightning flash was 0.00885 second.

The course taken by a lightning flash in time, as well as in space, shows enormous variety. The human eye, of course, is quite unable to separate the individual discharges following up one another at small fractions of a second. On the other hand, there are also flashes actually consisting of a single instantaneous stroke. There are sometimes separate discharges quite different in shape following up one another; these, of course, constitute independent flashes of such short duration that even the moving plate will reproduce them as well defined lines. Another frequent case is the simultaneous flashing up of several independent discharges. In such cases, there might, of course, be an electrical connection between the various flashes, and such phenomena, as in the case above discust, have actually been brought out already by lightning flash photographs with Professor Walter's triple camera.

How to Make a "Tattooing" Machine

By DAVID T. WEINBERG

(*Continued from page 293*)

diagram, since this tube acts as a sleeve in order that the needle will not penetrate the skin too deeply. This tube is also to contain the coloring fluid.

In the left-hand wooden end-piece slot the center so that a 6/32 screw will move freely—the slot extending ½ inch in length. Next drill a hole in the base so the tube can pass thru and have the tube fit flush against the end-piece, even with the slot. Then drill and tap a 6/32-inch hole at the upper end of the tube, so the screw will fit, thus allowing adjustment.

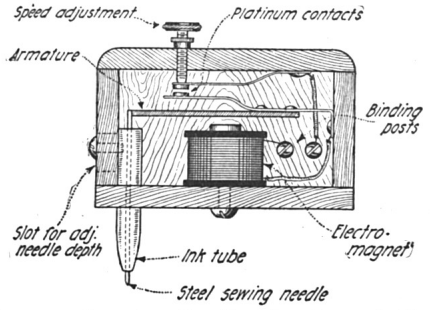

Diagram Showing the Construction of Electric Tattooing Machine, Which Can Be Readily Constructed From the Electro-magnets Found In An Old Buzzer Or Bell.

Under the top-board which is practically of the same dimensions as the base, place a springy piece of metal, either brass or steel, and attach a platinum or silver contact point to same; then arrange it as in diagram onto the top piece so that the contact will touch that on the vibrator.

The last few steps in completion of the tattooing machine are now at hand. Obtain two small binding posts and attach them to the frame as shown.

To use this tattooing machine connect a flexible telephone cord to the binding posts and to the terminals of about two or three dry cells in series, then turn the thumb screw until the vibrator operates at full rate of speed. Adjust the sleeve so that the needle when vibrating will project about 1/32-inch or a little less.

In tattooing, use an ink free from acid. Regular tattooing ink can be purchased from supply houses. After tattooing, wash the skin with peroxid.

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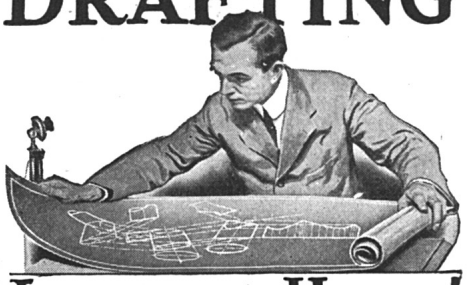

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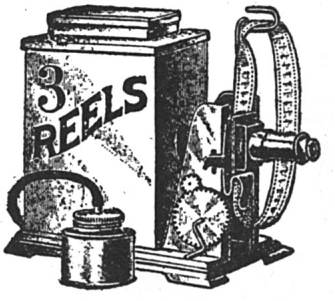

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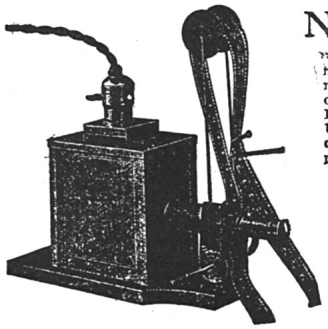

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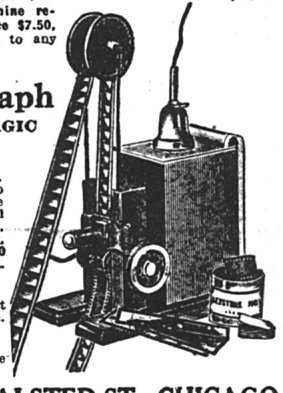

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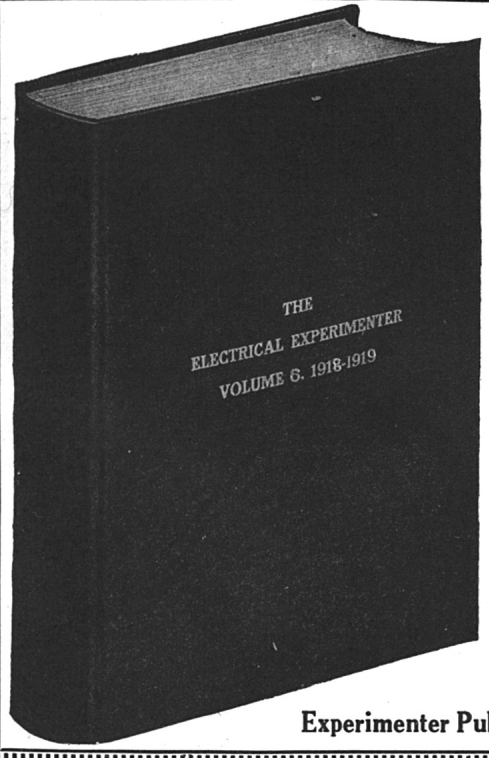

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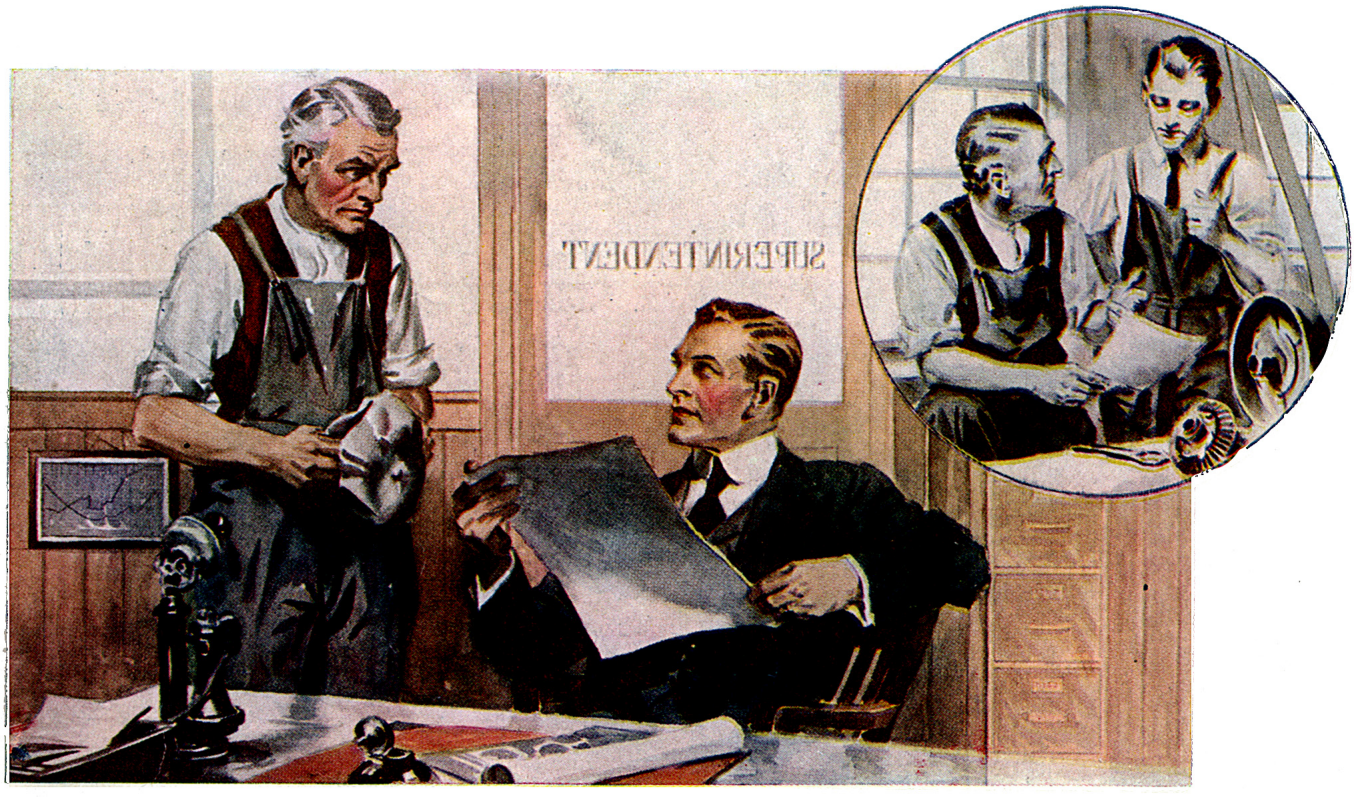

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